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An Investigation into Pancreatic Cancer Mortality in Peabody, Massachusetts

Massachusetts Department of Public Health

June, 1984

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Executive Summary

The Massachusetts Department of Public Health (DPH) investigated an elevation in mortality from cancer of the pancreas in Peabody for the period 1974 to 1978 and in one census tract (CT 2106) within Peabody for the period 1974 to 1982. The goals of the investigation were to determine whether mortality from pancreatic cancer in Peabody and CT 2106 was related to environmental contamination in Peabody and to identify risk factors associated with the disease.

Informants for those Peabody residents who died of pancreatic cancer between 1974 and 1982 were interviewed using a questionnaire developed by the DPH. Forty-one cases were included in the study. Two informants refused to participate in the study and four could not be reached by phone or letter. The response rate of the study was 87 percent. Information on residential history, occupational history, medical history , personal risk factors (such as smoking habits), and exposure to environmental contaminants was collected. In addition, existing environmental data for Peabody, including air, water, and soil testing results, were collected to identify potential environmental risk factors.

The residential history information collected during interviews was analyzed to determine if the cases were concentrated in any particular area of Peabody and could have been exposed to environmental pollutants from living in the neighborhood. Since most cancers have a latency period of 20 to 40 years after initial exposure to the carcinogenic agent(s), the location of residences of the cases for the years 1950, 1960, and 1970 were examined to investigate past exposures to environmental contaminants.

No concentration of cases in any particular area of Peabody was seen in 1950 or 1960. In fact, in 1950, at least one-half of the cases lived outside of Peabody, and in 1960, one-quarter of the cases were not Peabody residents. In 1970, more pancreatic cancer cases lived in CT 2106 than would be expected given the distribution of the Peabody population. Therefore, the apparent clustering in CT 2106 is a relatively recent phenomena. One possible explanation for this finding is that older people have tended to move into CT 2106 because of its residential characteristic and its proximity to Peabody center.

While a statistically significant excess of deaths from pancreatic cancer occurred over the five-year period 1974 to 1978, the pancreatic cancer mortality experience of Peabody for the two periods of 1969 to 1973 and 1979 to 1982 was as expected, based upon statewide rates. It appears that mortality from pancreatic cancer in Peabody has returned to expected levels.

The potential for exposure of the cases to air, water, and soil contaminants found at various locations within Peabody was assessed. It was concluded that actual exposure of the cases to environmental contaminants at these locations was highly unlikely. Because environmental data on Peabody exists back only to the early 1970s, exposures may have occurred in the 1940s, 50s, or 60s which were not possible to document.

In summary, the DPH concludes that pancreatic cancer mortality in Peabody is probably not related to living in Peabody. That is, no common exposure to environmental pollutants was found among the pancreatic cancer cases. One recommendation, however, is made in the report. The recommendation, although not related to the increase in pancreatic cancer mortality, was made because of citizen concern and information brought to DPH's attention during the investigation. DPH feels further analyses should

be conducted on soil samples at Pierpont Street Park. Preliminary soil analyses performed in 1983 revealed high levels of lead and chromium. Children playing in the park may be exposed to these toxic metals by ingestion and/or inhalation of soil particles or by skin contact with the soil.

Introduction

In February 1983, the Department of Public Health (DPH), as part of its routine function of examining death and disease rates in cities and towns across the Commonwealth, began its initial review of health statistics for Peabody. In July, the DPH was contacted by three independent groups concerned about pancreatic cancer mortality in Peabody. Those groups were: the office of Representative Theodore C. Speliotis, the Coalition for a Safer Peabody, and the office of Senator Frederick Berry.

Preliminary analysis of the period 1974 to 1982 showed a higher number of deaths from pancreatic cancer for Peabody as a whole and significantly more deaths from pancreatic cancer in one census tract (CT 2106) in South Peabody than were expected on a statewide basis. Appendix A contains these statistics. This report is a summary of the subsequent investigation of pancreatic cancer deaths in Peabody carried out by the DPH.

Section one of this report is a general discussion of pancreatic cancer including risk factors associated with it. Section two describes the survey carried out with the relatives of those Peabody residents who died of pancreatic cancer between 1974 and 1982. Section three contains the results of the questionnaire survey. Section four is a summary of existing environmental data in Peabody as they relate to the potential for exposure of Peabody pancreatic cancer cases. Section five contains the conclusions and recommendations of the Department. Appendices A through L follow the report.

Section 1. Cancer of the Pancreas

The pancreas, a gland located behind the stomach, produces substances, such as insulin, that regulate the level of sugar in blood and that aid digestion. Cancer of the pancreas is the fourth leading cause of cancer deaths in the United States. It is exceeded only by colon, lung, and breast cancer (American Cancer Society, 1982). However, pancreatic cancer deaths account for only five percent of the total number of cancer deaths (American Cancer Society, 1980).

For 1977, the U.S. age-adjusted death rates for pancreatic cancer were: 10.9 deaths for every 100,000 white males; 6.9 deaths for every 100,000 white females; 13.3 deaths for every 100,000 nonwhite males, and; 8.5 deaths for every 100,000 nonwhite females (National Cancer Institute, 1982).

Pancreatic cancer, like many other types of cancer, is more common in older people. It is quite rare in people under 40 years of age. In Connecticut, which has had a Tumor Registry since 1941, the incidence rate of pancreatic cancer in people 40 to 44 years of age is two cases of pancreatic cancer for every 100,000 people. For people between 80 and 84 years of age, 100 cases occur annually for every 100,000 people (MacMahon, 1982).

The annual incidence rate of pancreatic cancer has increased slowly over the past 30 years. One partial explanation for this increase is the improved diagnosis of pancreatic cancer. By the time it is diagnosed, the disease has usually progressed to advanced stages. For this reason, a low survival rate exists for pancreatic cancer.

Most types of cancer, including pancreatic cancer, are characterized by a long latency period. This means that typically 20 to 40 years elapse from the time of exposure to the cancer-causing substance or event and the manifestation of the disease. In this study, the latency period or the critical time with respect to exposure is, roughly, the years between 1940 and 1960.

1.1 Risk Factors

Many factors are thought to contribute to the occurrence of cancer. Epidemiologic studies (studies of human populations) and experimental animal studies are conducted to identify factors which may be associated with certain diseases. These factors, called risk factors, may increase a person's chances of developing cancer.

A review of the health literature on pancreatic cancer was conducted to identify risk factors associated with pancreatic cancer . None of the factors discussed below, however, accounts for more than about thirty percent of the incidence of pancreatic cancer (Lin et al, 1981). It may be that a combination of these factors increases a person's chances of developing cancer. Most pancreatic cancers are still unexplained.

1.2 Human Studies

Smoking

Several epidemiologic studies have shown that pancreatic cancer is about twice as common in heavy smokers as in nonsmokers (MacMahon, 1982; MacMahon et al, 1981; Wynder, 1975; Wynder et al, 1973; Moolgavkar et al, 1981). Researchers think that carcinogens in the tobacco are deposited in the pancreas by the bloodstream or, under certain conditions, by liver-produced bile which flows back to the pancreas (Wynder, 1973).

Coffee

A recent case-control study of 369 patients with pancreatic cancer and 644 control subjects (with various chronic diseases) has suggested an association between coffee drinking and pancreatic cancer (MacMahon, 1981). People who drank one or two cups per day were twice as likely to have

pancreatic cancer as noncoffee drinkers and people who drank three or more cups per day were about three times more likely. However, it is possible that the controls, many with gastrointestinal diseases, tended to drink less coffee than the cases because of their illnesses. More studies need to be done to investigate this potential risk factor.

In another hospital-based case-control study, pancreatic cancer cases drank significantly more decaffeinated coffee than people who served as controls in the study (Lin, 1981). It is possible, however, that the high consumption of decaffeinated coffee reflected generally high coffee consumption by the cases in the past. For this reason, caffeine cannot be ruled out as a possible risk factor.

Alcohol

Excessive use of alcohol has been suggested by some as a risk factor for pancreatic cancer (American Cancer Society, 1982). However, other researchers have concluded that it is unlikely that alcohol has any role in pancreatic cancer (MacMahon, 1982; Wynder, 1975).

Medical History

Some studies have shown increased frequencies (although not always statistically significant) of the following medical conditions in pancreatic cancer patients compared to controls: diabetes, gallstones, removal of the gallbladder, chronic inflammation of the pancreas, removal of the ovaries, spontaneous abortions, and uterine tumors (Lin, 1981; Fraumeni, 1975; Wynder, 1973). The role that any of these conditions plays in the development of pancreatic cancer is not clear at this time. Some researchers think that hormonal imbalance and chronic inflammation, characteristic of some of these conditions, may increase the likelihood of developing cancer (Soloway et al, 1966).

Trihalomethanes

One study investigated a potential correlation between cancer mortality and trihalomethanes (THMs; organic chemicals found in chlorinated water supplies) in a public drinking water system (Carlo et al, 1980). Over 4000 cases with five different types of cancer, including pancreatic cancer, were analyzed (using multiple regression methods) in terms of their source of drinking water and level of THMs. Investigators found a correlation between THMs and pancreatic cancer in white men. The authors of the report question the significance of this result because no correlation was found between females or nonwhites and THMs. This study, because of its design, could not control for important variables, such as smoking, which are associated with pancreatic cancer.

Asbestos

The discovery of very high levels of asbestos in the drinking water of Duluth, Minnesota prompted a long-term surveillance study of cancer rates in Duluth (Sigurdson,1981). For over 25 years, taconite wastes containing asbestos fibers were dumped by a mining company into Lake Superior, the source of Duluth's drinking water. It is still too early to make a complete assessment because sufficient time has not elapsed to accommodate the length of exposure and a reasonable induction period for the development of cancer. However, a statistically significant excess of pancreatic cancer was noted in the Duluth population compared to residents of Minneapolis and St. Paul.

Occupation

Another case-control study of 109 cases with pancreatic cancer and 109 controls found that the proportion of male pancreatic cancer patients who had been employed in the dry-cleaning business or in occupations involving close

exposure to gasoline (for example, service station and garage work) was significantly higher than for the male control subjects (Lin et al, 1981). The risk was increased five-fold among men who worked in these occupations for more than ten years.

1.3 Occupational Health Studies

One retrospective mortality study of 639 workers in a plant manufacturing beta-naphthylamine and benzidine showed a higher number of deaths from pancreatic cancer than was expected from statewide statistics (Mancuso, 1967). The number of cases was small, however, and the statistical significance of this finding was not reported. Occupations in which workers may be exposed to these chemicals include dyeworkers, chemical workers, rubber-tire manufacturing industry workers, manufacturers of coal gas, nickel refiners, copper smelters, and electrolysis workers.

A retrospective study of the causes of death of 1946 workers in a pigment plant (employed there between 1940 and 1969) who were exposed to lead and zinc chromates also showed an excess of pancreatic cancer deaths (Sheffet et al, 1982). The number of pancreatic cancer deaths was small and statistically insignificant and the researchers concluded that people exposed to chromates should be observed more closely for the occurrence of pancreatic cancer.

Peabody has been called the "Leather City of the World" because of its many leather processing industries. For this reason, the occupational health literature was reviewed to identify risks associated with employment in the

leather industry (see Appendix B). Several studies have shown an association between employment in the leather industry and bladder cancer. In addition, it is known that many carcinogens are used in leather processing and, depending upon the type of job, a worker may be exposed to any number of them.

1.4 Animal Studies

Several chemicals have produced pancreatic cancer in laboratory animals (Longnecker, 1983; Wynder, 1973; Mainz, 1974). Under a research grant provided by the National Cancer Institute, Longnecker reviewed experimental animal studies of pancreatic cancer (Longnecker, 1983). He identified several chemicals that induced pancreatic cancer in laboratory animals in long-term studies. The implications of such findings in terms of carcinogenic potential for humans are not known. The induction of a tumor in a particular organ, such as the pancreas, in one animal species does not mean that the same organ will be affected in man or any other animal species (Tomatis et al, 1973).

Section 2. Methodology

A detailed questionnaire was developed by the Department to collect information on those Peabody residents who died of pancreatic cancer between 1974 and 1982. The death certificate was obtained for each resident to verify the cause of death. The questionnaire included a medical, occupational, and residential history as well as questions on personal habits and environmental exposures. Table 1 lists the types of questions asked during the interviews. Questions on personal habits were developed after reviewing the health literature to identify risks factors for pancreatic cancer.

Table 1. Types of Information Obtained During Interviewing

Personal Habits:	smoking history coffee consumption tea consumption alcohol consumption hobbies
Environmental Exposures:	source of drinking water taste of drinking water contact with ponds in Peabody contact with industrial waste proximity to industry neighborhood air pollution neighborhood odors gardening
Occupational History	
Medical History:	heart disease gastrointestinal diseases respiratory disease surgical history reproductive history family medical history
Residential History	

Section 2.1 Selection of Cases

Initial review of the state's health statistics identified 49 Peabody residents who died of pancreatic cancer between 1974 and 1982. Between October 11, 1983 and November 1, 1983, forty-five interviews were conducted with relatives of the deceased (informants listed on the death certificates). Information obtained during the interviewing of two informants caused the removal of two cases from the study; one case never lived in Peabody while the second case lived in a Peabody nursing home only for a few months before her death. Two informants refused to participate in the study and four informants could not be reached by phone or letter after several attempts. Finally, two interviews were conducted with relatives of people who were not among the 49 cases originally identified. One person with pancreatic cancer had lived on the Peabody/Lynnfield line for ten years. The other person lived in Peabody for thirty years but died in 1970, four years before the time period of study. Although these last two cases were not included in the statistical analysis, interviews were conducted in case additional information might be provided by these informants. The statistical analysis, therefore, included 41 cases.

Section 3. Survey Results

Of the 41 cases, 22 were males and 19 were females. Figure 1 shows the age distribution at time of death of the cases. Sixty-six percent of the cases were age 65 and over. Two percent of the cases were under 45, five percent were under 55, and thirty-four percent were under 65.

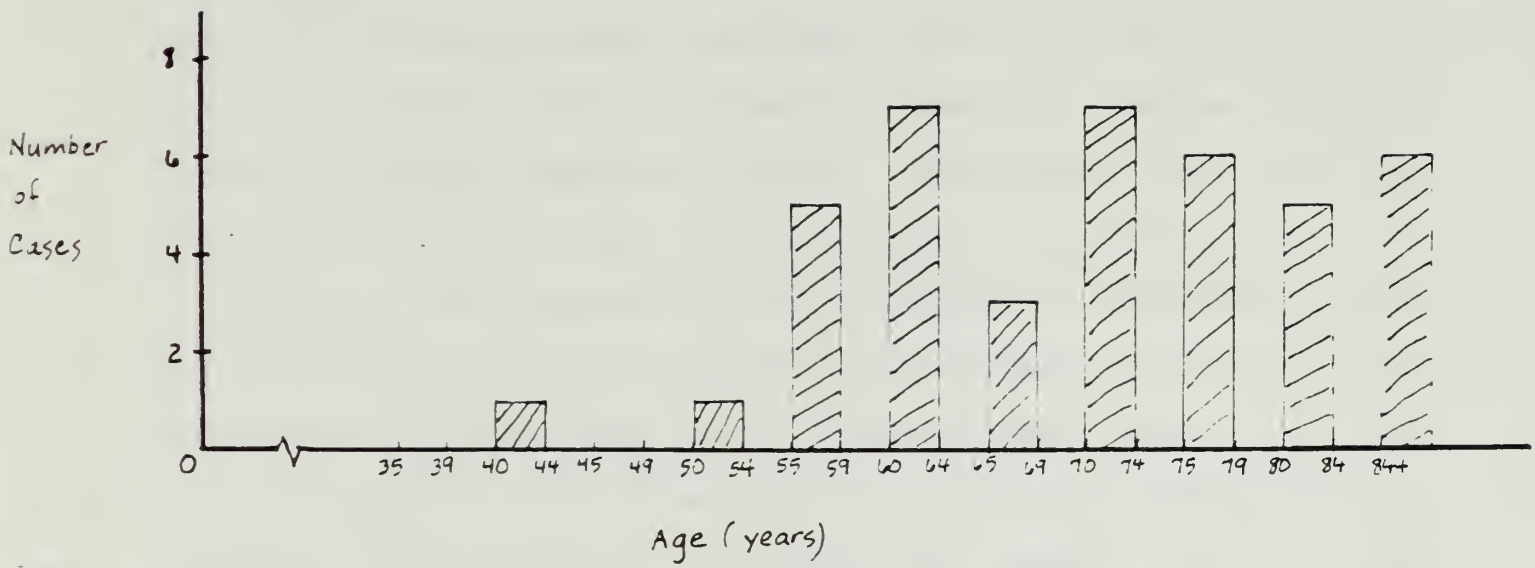


Figure 1. Age Distribution of the Peabody Pancreatic Cancer Cases at the Time of Death.

Occupational histories were obtained during the interviews. Nine (22%) of the cases worked in a tannery at some time in their lifetime; five (12%) of the cases worked in a tannery for 15 years of more. Four (10%) of the cases worked in metal fabrication jobs. Two of the cases were reported to have had daily exposure to asbestos - one was exposed to asbestos daily for four years while in the Navy and the other was exposed daily for 41 years on his job as an engineer. Eleven (27%) of the cases were housewives. One case worked as a foreman at a chemical company for 32 years. The remainder of the cases worked in miscellaneous types of jobs, such as clerical and maintenance work.

Informants were asked about the occupations of the cases' spouses. Occupational health studies have shown that the spouses of workers in certain industries may be at increased risk for certain diseases associated with their spouse's occupation; the presumption is that workers may bring home harmful substances on their clothes and thus expose family members. Of the 34 cases who were married, the spouses of seven of them (21%) were employed at some time in a leather factory. See Appendix B for the range of possible workplace exposures in the leather industry. One spouse worked at the Danvers Bleachery, three worked at an electronics firm, two worked in shoe factories, and one was employed in the dry-cleaning business. The remainder of the spouses worked at various jobs where exposure to toxic substances would have been highly unlikely.

Several questions pertained to potential environmental exposures associated with the residence where the case lived the longest or spent most of his or her life. One type of question sought people's opinions on the quality of the air and water in the case's neighborhood. A second type of question was designed to ascertain whether the cases had any common link with the environment (such as swimming in a particular pond).

Six (15%) of the 41 cases spent most of their lives outside of Peabody. Section 3.1 is an analysis of the residential history information collected during the interviews.

Of the 41 cases, only three (7%) were reported as ever swimming in Browns, Spring, or Sidneys Pond. Only one case was reported to have ever fished in these ponds.

Concern about potential contact with waste lagoons at Eastman Gelatine's facility has been raised. See Appendix H for a discussion of Eastman Gelatine. Six waste lime lagoons cover about 22 acres. Seven out of 41 (17%) cases were reported as having some contact with the lagoons; contact included working near, playing near, or living near the lagoons. No one was reported to have had actual physical contact.

Thirteen informants (32%) reported unusual odors in their neighborhood. The reported sources of the odors were the tanneries, the lime pits (Eastman Gelatine's waste lagoons), piggeries, the North River, and Borden Chemical Company. Seventeen (42%) informants reported that their relatives had noticed an unusual taste in the drinking water. Seven informants described the water as tasting fishy. Thirty-three (80%) informants said that their relatives did not complain of neighborhood air pollution.

Table 2 is a summary of information on personal risk factors collected during our interviews. Column one lists the characteristics examined and column two contains the number and percentage of total cases that possessed the characteristic. The frequency with which these characteristics appeared in cases in other studies of pancreatic cancer are shown in column three. Coffee and tea consumption patterns were generally similar among the cases in the different studies. A somewhat higher percentage of the Peabody cases were smokers than in MacMahon's study.

Table 2. Presence of Personal Risk Factors in Peabody Pancreatic Cancer Cases Compared to Other Studies

Characteristic Studied	Number of Peabody Cases	Percentage of Peabody Cases	Percentage Identified in Other Studies
Medical History			
History of Diabetes	7	17	7.4*
History of Gallbladder Disease	3	7	-
History of Gallstones	4	10	20.4*
History of Chronic Pancreatitis	1	2	6.5*
Removal of Gallbladder	5	12	13.8*
Removal of Ovary or Ovaries	3	7	35.0*
History of Uterine Tumor	4	10	27.5*
Coffee Consumption			
Drank more than 5 cups daily	10	24	24**
Drank 3 to 4 cups daily	12	29	29**
Drank 1 to 2 cups daily	12	29	42**
Drank less than 1 cup daily	10	25	-
Never drank coffee	4	10	5**
Unknown	3	7	-
Tea Consumption			
Drank 3 or more cups daily	5	12	13**
Drank 1 to 2 cups daily	14	34	60**
Drank less than 1 cup daily	10	25	-
Never drank tea	9	22	28**
Unknown	3	7	-
Smoking Habits			
Smoked less than 1 pack daily	7	17	11**
Smoked a pack or more daily	14	34	23**
Never smoked cigarettes	16	39	28**
Unknown	4	10	-

* Lin et al, 1981.
** MacMahon et al, 1981.

Section 3.1 Residential Clustering

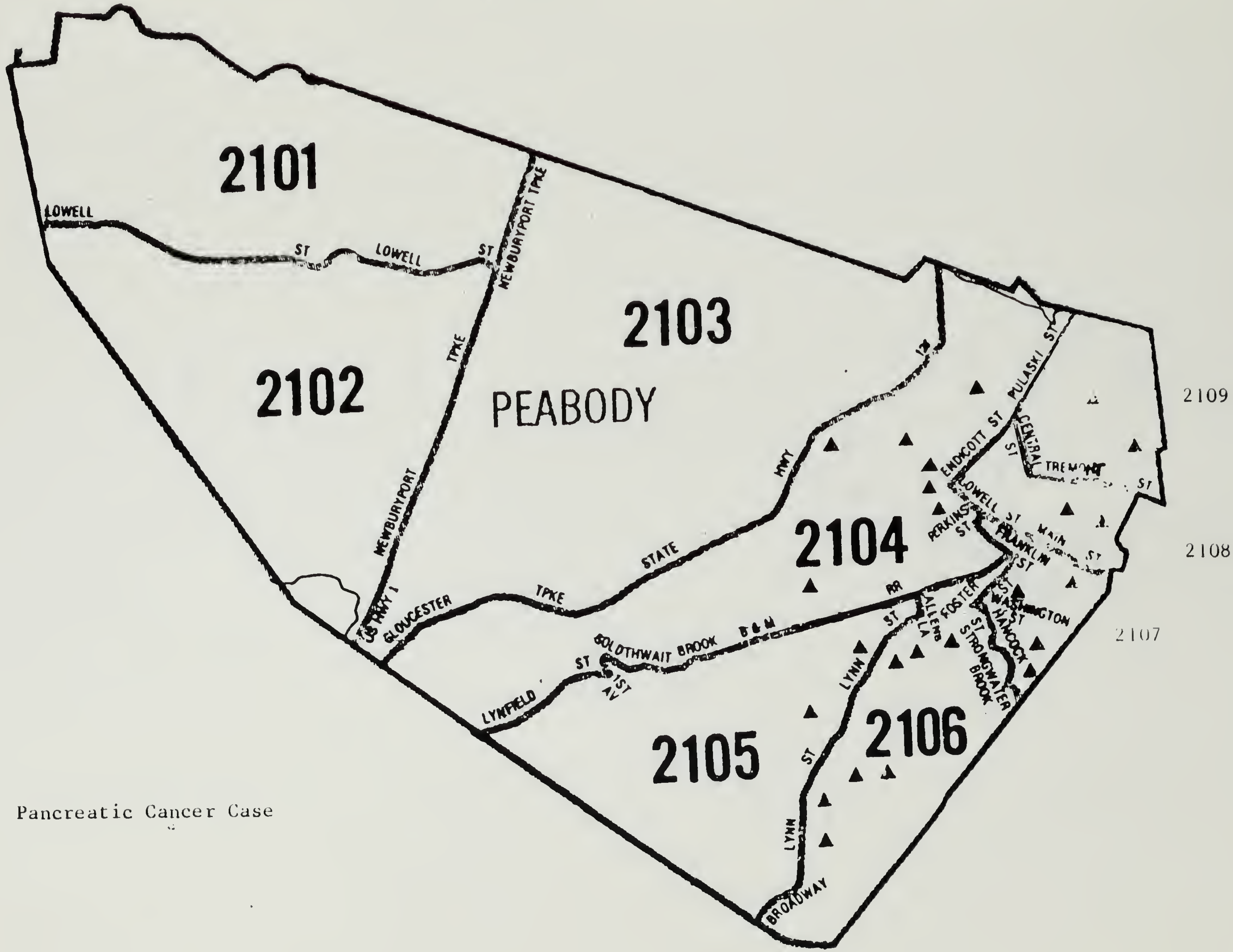
For the period 1974 to 1982, an excess number of deaths due to cancer of the pancreas occurred in census tract 2106 of Peabody. A total of twelve deaths occurred while only four deaths were expected, based upon statewide mortality rates for pancreatic cancer. The likelihood of this occurring by chance is extremely rare(9 out of 10,000). As stated earlier, most human cancers (with the exception of childhood leukemia) have a latency period of 20 to 40 years. For this reason, it is important to look at where the Peabody pancreatic cancer cases lived 20 to 40 years before the date of their deaths.

Using the residential history information collected on the questionnaire, the place of residence in 1950, 1960, and 1970 of the pancreatic cancer cases was plotted (by census tract). Nine census tracts exist in Peabody now; they are numbered 2101 through 2109. In 1950 and 1960, only five census tracts existed in Peabody. The maps on the following three pages illustrate where the cases lived in 1950, 1960, and 1970. U.S. Bureau of the Census population statistics were collected for Peabody's census tracts for these three years. To investigate whether the pancreatic cancer cases were concentrated in any particular area of Peabody during their latency periods (when exposure supposedly occurred), the following was computed:

(1) the percentage of the total number of pancreatic cancer cases who lived in a particular census tract

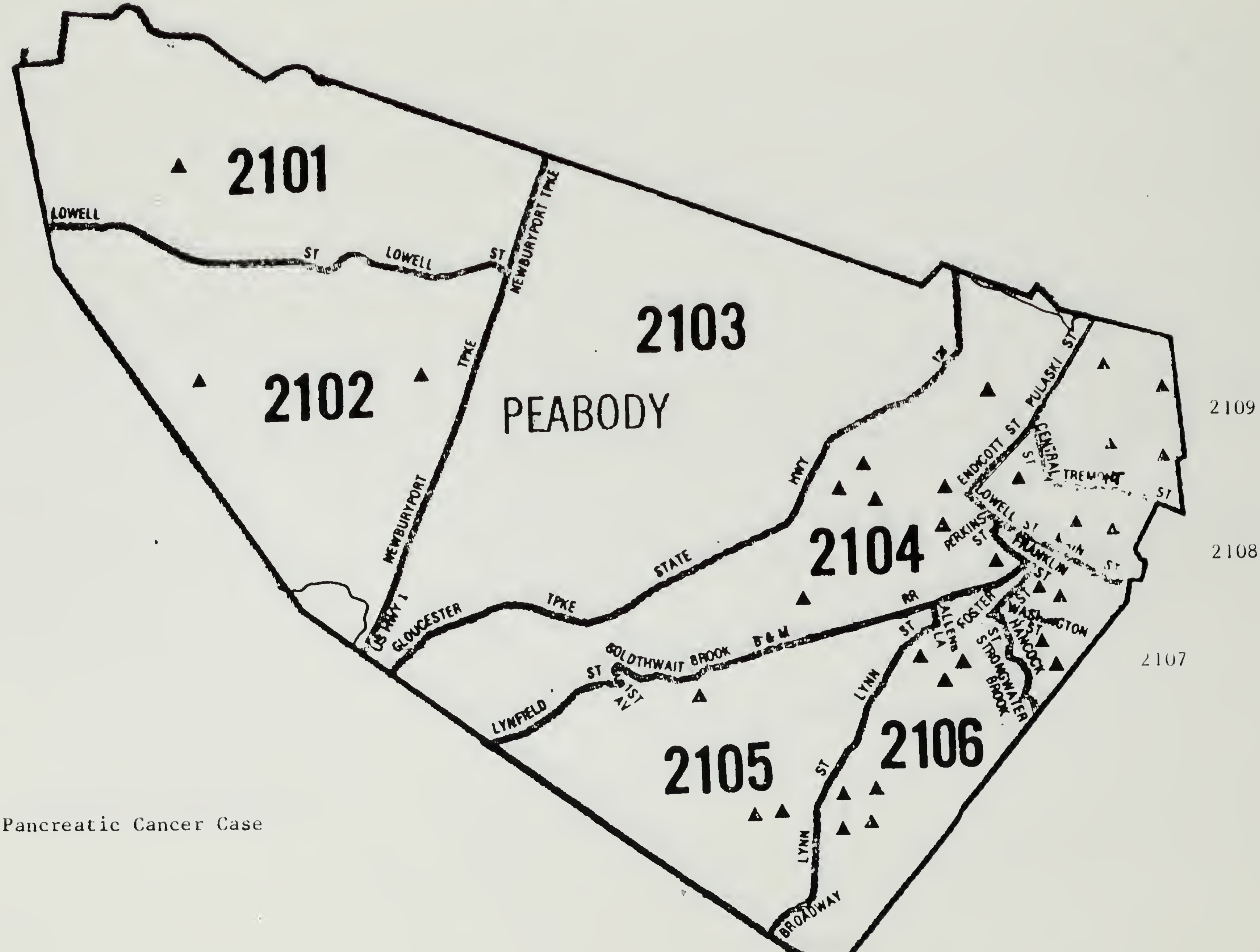
(2) the percentage of the total Peabody population who lived in that same census tract

Figure 2. Place of Residence of the Peabody Pancreatic Cancer Cases in 1950 by Census Tract.



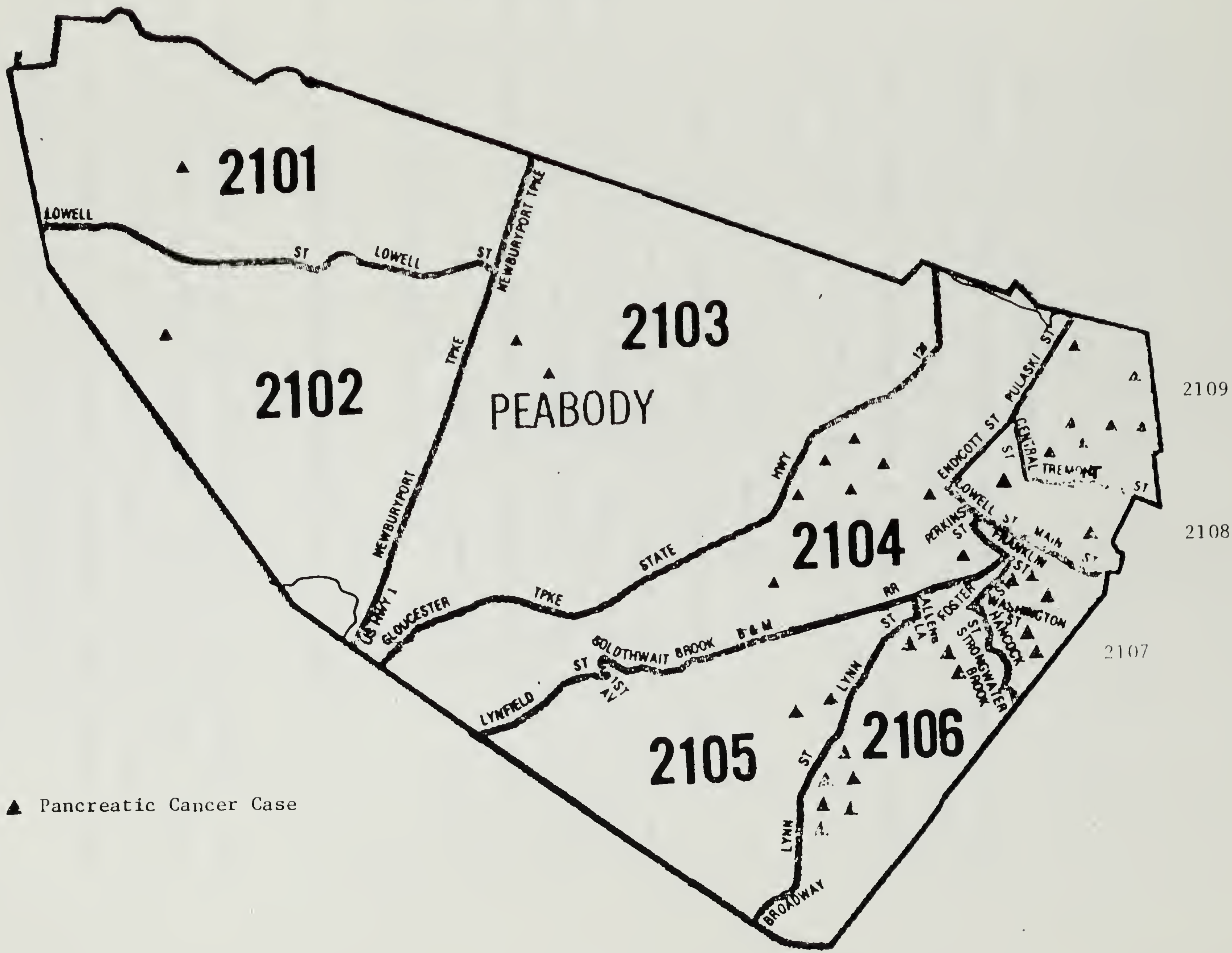
▲ Pancreatic Cancer Case

Figure 3. Place of Residence of the Peabody Pancreatic Cancer Cases in 1960 by Census Tract.



▲ Pancreatic Cancer Case

Figure 4. Place of Residence of the Peabody Pancreatic Cancer Cases in 1970 by Census Tract.



▲ Pancreatic Cancer Case

(3) the likelihood of observing (by chance) that percentage of cases in that particular census tract (using the binomial distribution statistical test)

A percentage of cases in a particular census tract significantly greater than the percentage of the total city population living in that tract (in a specified year) suggests an elevated number of cases in that tract. Appendix C contains the data used in this section and a brief description of the statistical test applied to the data.

In 1950 and 1960, no elevation in pancreatic cancer mortality in any particular census tract appeared. That is, the percentage of cases in any one of the census tracts, based on the population distribution of Peabody, was as expected for those two years. However, in 1970, more cases lived in Census Tracts 2106 and 2109 than were expected. Therefore, during the years critical to the development of the cancers, the cases did not tend to live in any particular area of the city. This means that common exposure of the cases to environmental pollutants probably did not occur.

Section 4. Environmental Survey and the Potential for Exposure

Many factors may contribute to the occurrence of a disease. These factors include occupational exposures, nutritional status, genetic predisposition, personal habits such as excessive alcohol consumption and smoking, and exposure to environmental pollutants. This section reviews possible exposure of the cases to environmental pollutants.

For an environmental pollutant to exert an adverse effect on a person, it is necessary for that person to be exposed to the substance and to absorb it into the body. Three possible routes of exposure exist: inhalation, ingestion, and skin contact. Sources of exposure include air pollutants (taken in by breathing); water contaminants (ingested in drinking water or absorbed through the skin while swimming); soil contaminants (absorbed through the skin upon contact or ingested as dust particles); and food contaminants (ingested in the diet).

Due to the latency period of cancer, it would be ideal to have environmental data for each of these routes from at least 1950 onward. Most of the data for Peabody, however, are only from the early 1970s to the present. Lacking earlier information, past and present industries and dumpsites in Peabody are analyzed to determine whether contaminants associated with them could have contributed to the incidence of pancreatic cancer.

4.1 Environmental Testing

This section has two parts. The first part discusses results of testing performed on Peabody's drinking water. The second part addresses specific sites where exposure to contaminants may have occurred. Only summaries of environmental data are presented here. Detailed results are given in the appendices.

4.1.a Tests on Peabody Drinking Water

Some residents in Peabody have private wells and do not get their water from a public supply. Only two of the forty-one cases, however, used private well water. Nearly all the other cases used water from the downtown system of the Peabody water supply (see Appendix E for a more detailed description of Peabody's water system). Testing for environmental contaminants in this water is therefore of particular interest.

Water quality data for Peabody exists from 1975 to the present (see Appendix F). Tests have been conducted on samples from Spring Pond, Suntaug Lake, tap water, and the Ipswich River (downtown system); and from Winona Pond, the Johnson Street well, and the Pine Street well (West Peabody System). Analyses of standard water quality parameters required by the federal Safe Drinking Water Act and the Drinking Water Regulations of Massachusetts were carried out. These include pH, turbidity, inorganic solutes, certain pesticides, microbiological contaminants and others (See Appendix F).

With regard to organic and inorganic chemicals (including metals), levels found in the drinking water were usually within federal standards. In some samples, iron concentrations exceeded the federal secondary standard of 0.3 ppm. Sodium levels in the tap water slightly exceeded the state standard of 20 ppm in several samples.

Trihalomethanes (THMs) have also been tested in Peabody water. THMs are present in every chlorinated drinking water supply. They are formed as a by-product of the chlorination process (used to control microbial contamination) when chlorine reacts with naturally occurring substances in the water. In tests done in 1976, 1980, and 1982-1984, THMs were within the acceptable levels designated by the EPA (100 ppb averaged over 4 quarterly samples)(see Appendix F).

From the results of testing, Peabody's water supply shows no unusual level of any contaminant. However, there have been numerous complaints by local residents and informants for the cases regarding the quality of the drinking water. It would be useful to know which substances, if any, were present in the drinking water 20 to 40 years before the mid to late 1970s. Since this information is not available, it is not possible to draw firm conclusions regarding the relationship between drinking water and pancreatic cancer.

4.1.b Testing of Specific Sites

This section addresses specific sites in Peabody where exposure to environmental contaminants may have occurred. For each site, possible routes of exposure are discussed, as well as what is known about exposure to any of the cases. For the location of the sites, see Appendix G, Figure G.1.

1. Eastman Gelatine Lagoons - The lagoons, located off Wheeler Street in CT 2106, cover an area of 22 acres. Eastman Gelatine, a manufacturer of high-quality photographic gelatines, has dumped wastes from their operations into the lagoons for over 50 years. The lagoons also contain waste dumped by glue factories which occupied the site for over 100 years prior to Eastman Gelatine.

According to our survey, no case had any actual physical contact with the lagoon site. This rules out the dermal route of exposure from the site itself. Seepage from the lagoons has entered both Sidney's Pond and a potential aquifer found in the Meadow Pond area (C.T. Main, 1983, pp. 4-10). According to the survey, however, none of the cases ever swam or fished in Sidney's Pond. In addition, the aquifer has never been part of any water supply system. The lagoons are also downstream from Spring Pond, which is part of the Peabody water system. Thus, even if wastes from the lagoons entered various waters in the area, the cases were not exposed to the wastes via their drinking water.

Area residents have complained of odors produced from the lagoons. This raises the question of whether exposure to toxic substances in the air may have contributed to the elevation of pancreatic cancer. In April 1983, Eastman Gelatine hired consultants, TRC, to do air sampling over the lagoons. Samples were also taken upwind and downwind from the site. The tests detected 4 kinds of amines and ammonia over the lagoons themselves, but not at the up-wind and downwind sites. The source of the amines and ammonia is probably the decomposition of proteinaceous material. These substances are quite basic, have a fishy odor, and are very irritating to tissue.

Amines, under neutral or acidic conditions and in the presence of nitrogen oxide compounds, have the potential of converting to nitrosamines. Nitrosamines are suspected to be carcinogenic. Amines are, however, ubiquitous in the environment. Given the lack of past air data from the lagoons and the complexity of nitrosamine formation, it is impossible to predict how much, if any, conversion took place. Furthermore, a review of the residences of cases in 1950 and in 1960 showed only six of the forty-one cases lived within a quarter mile radius of the site. Thus, the amines detected over the lagoons do not appear to be an important risk factor in this study.

2. Salem Acres - Another environmental concern for residents is Salem Acres, located in Salem, just over the border from the Eastman Gelatine lagoons. Closed in 1969, this dumpsite, consisting of four sludge pits, was used for many years by the South Essex Sewerage District (SESD). Midnight dumpers are also suspected of dumping tannery wastes in Salem Acres (EPA Potential Hazardous Waste Site Identification and Preliminary Assessment, 1983).

A consultant for EPA, the NUS Corporation, conducted tests at Salem Acres. NUS sampled soil from the sludge pits, air above the pits, and surface water and groundwater in the area.

Breathing zone samples of air above holes drilled in the sludge pits indicated "nothing unusual" was found (Panaro). Since Salem Acres is downstream from Spring Pond, it does not impact on Peabody's water supply system. Grit samples taken directly from the pits show levels of about 800-900 ppm

chromium in two of the four pits, and about 25 ppm chromium in the other two pits (Panaro). These preliminary results are still being evaluated. The 800-900 ppm measurements are elevated levels (the mean in uncontaminated soils is 100 ppm, with a range of 5-3000 ppm).

In summary, Salem Acres can probably be ruled out as a source of exposure of environmental contaminants to the cases. Salem Acres does not impact on Peabody's water supply, and for exposure to the chromium found in the pits to occur, actual skin contact would have had to take place since chromium is not volatile.

3. Pierpont Street Park - This location was once the site of a number of leather companies. The site is believed to have been used for dumping tannery wastes in the past (Peabody Community Development Department, local residents). About 10 years ago, a large fire destroyed the existing factories. Since then, the area has been a vacant lot used by neighborhood children. In 1981, the site was developed into a playground.

No question about contact with Pierpont Park was on the questionnaire. Nonetheless, two points can be made. First, before 1973 (about the time of the fire), the area was occupied by various factories, making contact with the area by the cases unlikely. Also, no case worked in either B.M. Moore or Central Leather, which were located on the site. Secondly, not many cases lived near the area. In 1950 and again in 1960, only one case lived within a quarter mile radius of the site. In 1970, only two cases lived within a quarter mile radius of the site. Thus, it is highly unlikely to be a risk factor for pancreatic cancer in our study.

In preparation for developing the site into a playground, a number of soil analyses were conducted at Pierport Street Park. These results are shown in Appendix J. Preliminary testing showed high levels of chromium and lead in the soil. Lead is a neurotoxin and chromium in its hexavalent state is an irritant and a carcinogen. The soil analyses did not determine whether the chromium was in the hexavalent state or in its less toxic trivalent state.

4. Strongwater Brook - Strongwater Brook originates in South Peabody and Salem, flowing in a northerly direction through parts of CT 2106, by Pierpont Street Park, and into the North River.

The interviewers did not ask the informants whether cases had any contact with the brook. However, only six of the forty-one cases lived within a quarter mile of the brook in 1950 and again in 1960. Furthermore, since it is downstream from Spring Pond, Strongwater Brook does not impact on Peabody's water supply. Therefore, the brook is not a likely risk factor in the elevation of pancreatic cancer in Peabody.

5. Peabody Landfill and GCR Landfill - The Peabody landfill has been used by the city since the 1950s. After Salem Acres was closed in 1969, the SESD began disposing of its grit and scum wastes at the Peabody landfill. Due to concern about leaching from the landfill into surrounding surface and groundwaters, a consultant to DEQE, Tighe and Bond/SCI, conducted testing in 1980-1981 of groundwater, surface water, and leachate at the landfill.

The Peabody landfill is in a different drainage basin than Suntaug Lake, and thus poses no risk of contamination of that water supply. Surface and subsurface waters in the basin where the landfill is located eventually discharge into Goldthwaite Brook (EIR, Tighe and Bond, 1981, pp. 4-9).

The GCR landfill is adjacent to the Peabody landfill. Testing was done in September 1983 by GCR Engineering on leachate and surface and groundwaters around the landfill. As with the Peabody landfill, the GCR landfill does not impact on Peabody's water system because surface water drainage flows towards Cedar Pond and Cedar Swamp, which drain eastward into Goldthwaite Brook (GHR,1983, pp. A-10). Net groundwater flow from the landfill is toward the southeast (GHR,1983, pp. A-12).

No plausible route of exposure between contaminants in the landfills and our cases could be identified. Furthermore, no cases lived near the site. Therefore, it is highly unlikely that exposure to contaminants in the landfills contributed to the development of these cancers.

6. Other Areas- Some citizens have expressed concerns over flooding of homes in the vicinity of Remis Industries. Residences of cases were reviewed to determine whether they may have lived in the homes which were flooded. In 1950, no cases lived near Remis Industries. In 1960, one case lived in the vicinity (near the corner of Lynnfield Street and Farm Road), and in 1970, no case lived in the area.

Other flooding has occurred in homes on Fountain Street, near Pierpont Street Park, when Strongwater Brook overflows its banks after very heavy rains. No case, however, lived on Fountain Street.

Section 5. Conclusions and Recommendations

The goals of this study were three-fold:

- o to investigate whether mortality from pancreatic cancer in Peabody is related to environmental contamination in Peabody
- o to collect information on risk factors associated with the disease
- o to investigate an apparent concentration of cases of pancreatic cancer in CT 2106.

The mortality rates for cancer of the pancreas were examined for three time periods. The trend in pancreatic cancer in Peabody is as follows: from 1969 to 1973, no significant excess of pancreatic cancer cases was seen; from 1974 to 1978, a statistically significant elevation in pancreatic cancer mortality occurred; and, between 1979 and 1982, no significant excess was noted. Thus, for Peabody as a whole, the significant elevation appeared during the five-year period 1974 to 1978; it appears that the incidence of pancreatic cancer may be returning to expected levels.

Existing environmental data for Peabody, including air, water, and soil testing results, were collected and reviewed. The potential for exposure of the cases to environmental contaminants was considered. Based upon a careful review of the testing data and the Peabody environment, actual exposure of the cases to the industrial or environmental contaminants identified in the report seems highly unlikely. Although legitimate concerns exist regarding past waste disposal practices in Peabody and potential threats to groundwater

and surface waters, no connection between environmental contaminants and the incidence of pancreatic cancer could be made. However, because of the long latency period of most cancers, exposures could have occurred back in the 1940s and 1950s which could not be documented.

Information on personal risk factors was collected during the questionnaire survey. In general, no characteristics or personal habits of the cases were noteworthy.

Due to the large number of leather tanneries in Peabody, employment in the leather industry was of interest. Twenty-two percent of the cases (and 21 percent of the spouses) were employed in a tannery at some time in their lifetime. However, in 1968, less than ten percent of the cases worked in the leather industry while twelve percent of Peabody's labor force was employed in leather at this time. Similarly, while sixteen percent of the Peabody labor force was employed in leather in 1960, less than fifteen percent of the cases were working in leather then. Therefore, the percentage of cases who worked in the leather industry was approximately the same as the percentage of Peabody residents who were employed in leather during those times.

In 1950 and 1960, the time of the latency period, no clustering of cases in any particular area of Peabody was seen. In 1970, more pancreatic cancer cases lived in CT 2106 and 2109 than would be expected given the distribution of the Peabody population. Therefore, the apparent clustering in CT 2106 is a relatively recent phenomena. It could be that persons who were later to develop pancreatic cancer tended to move into CT 2106; perhaps for convenience and proximity to Peabody center or because of neighborhood characteristics. In CT 2109, a plausible explanation for the elevation is the large elderly population in that area.

Fifteen percent of the cases spent most of their lives outside of Peabody. In 1950, at least one-half of the cases lived outside of Peabody and in 1960 one-quarter of the cases were not Peabody residents.

Seventeen informants said that their relatives who died of pancreatic cancer had reported an unusual taste in their drinking water. According to city water officials, the taste is due to algae, which are nonpathogenic organisms commonly encountered in water impoundments. They acknowledge a long-standing problem with algae (which have occurred in large "blooms" in the past) in the city water supply and have taken steps to alleviate the problem. For example, some point sources, such as drains discharging high phosphate waters, which encourage algae growth, have been eliminated. The Cedar Grove Reservoir was cleaned and disinfected in September 1983, and Winona Pond will be aerated this spring. In the last couple of years, there have been only minor algal blooms.

Several limitations exist in this investigation. Environmental sampling data and exposure information for the latency period was lacking. The quality of the information obtained by interviewing informants for the pancreatic cancer cases depended on the closeness and relationship of the informant to the case and the length of time which had elapsed since the death of the case. Reporting bias may have occurred if the informant felt that pancreatic cancer mortality was or was not related to living in Peabody. Because the etiology of pancreatic cancer is still not well understood, it is possible that information on important but unknown risk factors was not collected. Although

deductions could be made about contact of the cases with Pierpont Street Park and Strongwater Brook, the questionnaire did not contain specific questions about either area. Finally, instability and lack of statistical power associated with the small number of cases characterize this investigation.

Based upon the analysis of data collected in this study, the Department feels that pancreatic cancer mortality in Peabody is probably not related to living in Peabody. However, one recommendation is made below and is prompted by information brought to the Department's attention through this study. The Department recommends that further analyses be conducted on soil samples at Pierpont Street Park as soon as possible. Although exposure to this area is not a likely risk factor for pancreatic cancer in Peabody, more study is needed to verify preliminary findings of elevated levels of lead and chromium in the soil of the park. Furthermore, the tests should determine whether the chromium is hexavelent or trivalent. Potential exposure of children playing on the site by ingestion or inhalation of contaminated soil particles or skin contact is of concern.

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Appendix A

Peabody Mortality Statistics for Cancer of the Pancreas

This appendix contains a summary of the statistics on cancer of the pancreas in Peabody and CT 2106 for various periods. Table A.1 is a summary of these statistics. Column two contains the observed number of pancreatic cancer deaths and column three contains the number of deaths by cancer of the pancreas expected if statewide mortality rates applied. Column four contains standardized mortality ratios (SMRs) - the ratio of the observed number of cases to the expected number, multiplied by 100. An SMR over 100 indicates that more deaths occurred than would be expected. An SMR below 100 indicates that fewer deaths occurred than expected. For example, an SMR of 136 is interpreted as an excess of 36% of deaths over the expected number. Column five refers to the statistical significance of the SMR - whether the difference between the observed and expected number of deaths can be explained by chance (random variation of the disease within the population) or is most likely an excess of deaths by cancer of the pancreas. A yes in column five means that the difference is statistically significant and cannot be attributed to chance occurrence. The P value is the probability that the difference is due to chance; a small P value (usually below 0.05) is, by convention, interpreted as showing statistical significance.

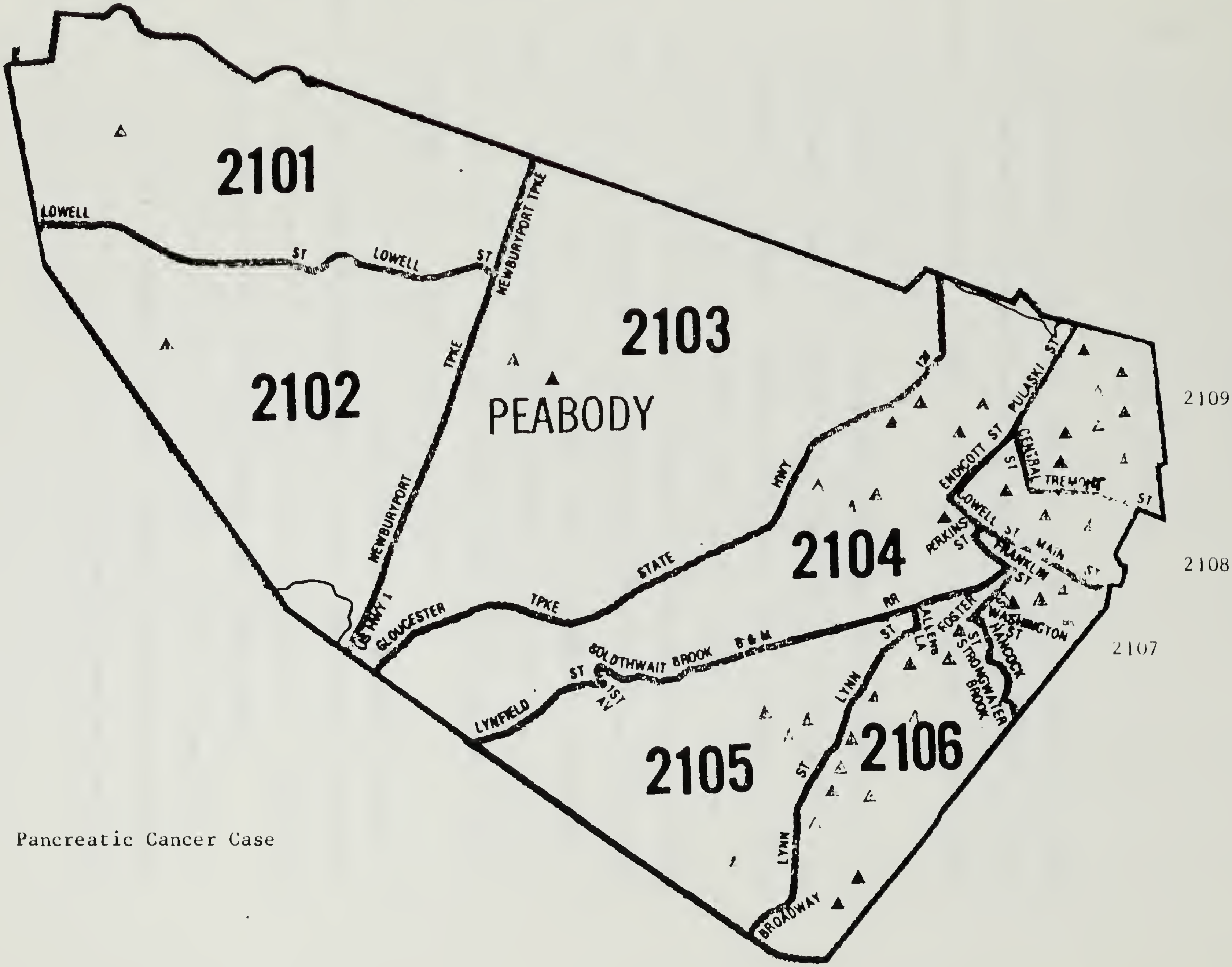
Table A.1. Standardized Mortality Ratios (SMRs) for Cancer of the Pancreas in Peabody, Massachusetts

	Period Covered		Observed	Expected	SMR	Statistical Significance (P Value)**
I. Peabody						
(As A Whole)	1969-1973	M*	9	10.4	87	no
		F	12	8.8	136	no
		T	21	19.2	109	no
	1974-1978	M	15	10.1	149	no
		F	14	8.7	161	no
		T	29	18.8	154	yes (0.02)
	1979-1982	M	12	8.8	137	no
		F	8	8.8	91	no
		T	20	17.6	114	no
II. Census Tract						
2106	1974-1978	T	6	2.4	250	yes (0.04)
	1979-1982	T	6	2.0	300	yes (0.02)

* M = males; F = females; T = both sexes combined
** Level of statistical significance at P < 0.05

The residences of the cases at their times of death were plotted on Figure A.1. The concentration of cases appeared to be east of Route 128, in the urban center of Peabody. To the west of Route 128 are the more surburban and rural parts of the city. Based upon the population distribution of the city, the location of elderly housing projects, and discussions with city officials and concerned citizens, two possible clusters of cases were identified - CT 2106 and CT 2105. Even though CT 2107, 2108, 2109 appear to have elevations, the population of Peabody (including the elderly) is concentrated here. After adjusting death rates for both age and sex, it was determined that CT 2106 (and not CT 2105) experienced a higher mortality rate for pancreatic cancer than would be expected (based upon statewide statistics).

Figure A.1. Place of Residence of the Peabody Pancreatic Cancer Cases at the Time of Death.



Appendix B

Leather Industry

The International Agency for Research on Cancer (IARC) has studied extensively the health risks associated with employment in various industries (IARC, 1981). Following is a summary of IARC's evaluation of the leather tanning and processing industry:

> "The chemical complexity of the tanning process and the wide variety of finishing agents used will almost certainly result in worker exposure via inhalation and dermal contact to multiple and changing chemical pollutants. Employment in tanneries may entail exposure to a number of chemicals for which there is evidence of carcinogenicity in humans and/or laboratory animals ... A positive association between employment in the leather industry and bladder cancer is supported by a number of studies. Suggested associations between employment in the leather industry and cancer of the lung, larynx, buccal cavity, pharynx, kidney, and lymphomas exist." (IARC, 1981, pp. 243-244)

The risk faced by any particular worker depends on the degree and type of exposure, which in turn varies with specific jobs and work areas in tanneries. Additional factors may also influence a person's chances of developing cancer, such as smoking habits, genetic factors, and health status.

Table B.1 contains an outline of the major steps in the manufacture of leather and the types of chemicals typically used in the various processes. Table B.2, taken from the IARC report, lists specific chemicals associated with various tannery operations.

Table B.1. Outline of Major Steps in the Manufacture of Leather

Major Steps	Chemicals Used in the Process
I. Preliminary Processes	Sulfur compounds, aliphatic amines
1. Sorting and trimming hides and skins	
2. Soaking	
3. Liming	
4. Unhairing	
5. Fleshing	
6. Bating	
7. Pickling	
8. Degreasing	
II. Tanning	Inorganic chromium compounds (hexavalent and trivalent), tannins
1. Vegetable	
2. Chrome	
3. Other nonsynthetic tannages	
4. Synthetic organic tannages	
III. Final Processes	Coal tar dyes, pigments
1. Splitting and shaving	
2. Dyeing	
3. Fatliquoring, oiling, stuffing	
4. Mechanical softening	
5. Application of final finishes	
6. Boarding	

Source: DeCoufle, 1979.

Table B.2. Chemicals Associated with Various Operations in the Tannery Process

Beam House

Hydrogen sulfide
Ammonia

Tanyard

Sulfuric acid
Chromium (hexavalent)
Chromium (trivalent)
Hydrogen sulfide
Sodium 2,4,5 -trichlorophenate

Retan, colour, fat liquor

Formic acid
Chromium (trivalent)
Copper
Cobalt
Ammonia
Benzidine
Benzidine 2,2-disulphonic acid
1-Naphthalene sulphonic acid
3,3-Dimethoxybenzidine

Finishing

Petroleum distillates
Butyl cellosolve
Tetrachloroethylene
Xylene
Methyl ethyl ketone
Butyl acetate
Toluene
Methyl isobutyl ketone
Acetone
Formaldehyde
Isopropyl alcohol
Benzene

Source: IARC, 1981

Another chemical which has been identified in tannery environments is N-nitrosodimethylamine or NDMA (Rounbehler et al,1979). NDMA is an animal carcinogen (IARC,1982). The source of NDMA in tanneries is not known but it is thought that dimethylamine used in the unhairing process reacts with nitrogen compounds in the air to form NDMA. Rounbehler et al reported that limited testing of the air immediately adjacent to tanneries has led them to believe NDMA is probably present in and near tanning facilities.

The results of a proportional mortality study of 2,798 shoe and leather workers in three Massachusetts towns (Brockton, Haverhill, and Peabody) were recently reported (Garabrant et al, 1984). A statistically significant excess of stomach cancer was present among male leather workers while a nonsignificant excess was also seen among female leather workers. However,the authors felt that this excess would disappear if the expected proportion of deaths from stomach cancer was based upon Massachusetts stomach cancer rates instead of U.S. rates. Examination of the causes of death of 289 leather workers according to the type of job they performed (hide preparation, tanning, finishing, or maintenance) was also carried out. Lung cancer was associated more strongly with leather tanning than with the other processes; however, the number of cases was small and therefore the results should be interpreted cautiously.

Appendix C

Statistical Evaluation of Clustering

A brief description follows of the statistical test applied to the data on residential clustering described in Section 3.1 of the report. As discussed earlier, the place of residence in 1950, 1960, and 1970 of the pancreatic cancer cases was plotted (by census tract). The percentage of the total number of pancreatic cancer cases who lived in a particular census tract was then compared to the percentage of the total Peabody population who lived in that same census tract. If the percentage of cases was higher than the percentage of the population in the census tract, then the percentages were tested to see if they were statistically significantly different. (See Tables C.1, C.2, and C.3.)

The binomial formula was used to compute the probability that the observed number (or greater) of cases in a particular census tract, as a proportion of the total number of cases in Peabody, could be explained by chance. This proportion was compared to what would have been expected, under a binomial distribution (a statistical distribution which describes the data). Below is the binomial formula; for a more detailed discussion of this topic, see Colton et al.

Table C.1. Place of Residence By Census Tract in 1950 of Peabody Pancreatic Cancer Cases

	13	14	15	16	17
Census Tract	(2109)	(2108)	(2107)	(2101,02,03,04)	(2105,2106)
Number of Cases in Census Tract	2	2	4	7 (5.06±2)*	9 (6.24±2.15)
Number of Cases in City **	24	24	24	24	24
Census Tract Population	3369	3955	4636	4789	5896
Total City Population	22,645	22,645	22,645	22,645	22,645
Percentage of Cases in Census Tract	8.3	8.3	16.7	29.2	37.6
Percentage of Total City Population in Census Tract	14.9	17.5	20.5	21.1	26.0
Apparent Elevation				Yes	Yes
Level of Statistical Significance (P value)				0.229	0.147
Statistically Significant Elevation				No	No

*Expected number of cases plus or minus the standard deviation.

**From a total of 43. The remainder were not living in Peabody in 1950.

Table C.2. Place of Residence By Census Tract in 1960 of Peabody Pancreatic Cancer Cases

	13	14	15	16	17
Census Tract	(2109)	(2108)	(2107)	(2101,02,03,04)	(2105,2106)
Number of Cases in Census Tract	4 (3.84±1.84)*	3	4	11	10 (8.26±2.48)
Number of Cases in City **	32	32	32	32	32
Census Tract Population	3863	3391	4148	12,496	8304
Total City Population	32,202	32,202	32,202	32,202	32,202
Percentage of Cases in Census Tract	12.5	9.4	12.5	34.4	31.3
Percentage of Total City Population in Census Tract	12.0	10.5	12.9	38.3	25.8
Apparent Elevation	Yes				Yes
Level of Statistical Significance (P value)	0.55				0.30
Statistically Significant Elevation	No				No

*Expected number of cases plus or minus the standard deviation.

**From a total of 43. The remainder were not living in Peabody in 1960.

Table C.3. Place of Residence By Census Tract in 1970 of Peabody Pancreatic Cancer Cases

Census Tract	2109	2108	2107	2106	2105	2104	2103	2102	2101
Number of Cases in Census Tract	7 (3.±1.7)*	2	5 (3.1±.7)	9 (4.±1.8)	2	8 (5.6±2.2)	2	1	1
Number of Cases in City **	37	37	37	37	37	37	37	37	37
Census Tract Population	4102	3551	3932	4786	5259	7348	5657	6371	7074
Total City Population	48,080 .... (same)								
Percentage of Cases in Census Tract	18.9	5.4	13.5	24.3	5.4	21.6	5.4	2.7	2.7
Percentage of Total City Population in Census Tract	8.5	7.4	8.2	9.9	10.9	15.3	11.8	13.3	14.7
Apparent Elevation	Yes		Yes	Yes		Yes			
Level of Statistical Significance (P value)	0.034		0.183	0.009		0.196			
Statistically Significant Elevation	Yes		No	Yes		No			

*Expected number of cases plus or minus the standard deviation.

**From a total of 42. The remainder were not living in Peabody in 1970.

The binomial formula states that:

$$\text{the probability of observing x or more cases} = \binom{n}{x} \theta^{x} (1 - \theta)^{n-x}$$

where x = the number of cases in a census tract

n = the number of cases in the city

θ = the probability of observing a case in the census tract

As is standard practice, a probability of less than 0.05 was considered to be statistically significant.

Appendix D

Peabody Industrial History

Peabody has been called the "Leather City of the World" with tanneries dating back to pre-Revolutionary times. The industry expanded greatly at the beginning of this century, making a section of Main Street one of the largest leather processing districts in the world. In 1919, there were 91 leather establishments. The industry gradually declined, with the number of firms decreasing to 68 in 1955, and to 50 in 1968. By 1968, tanneries employed only 51% of the manufacturing employees (3,026 employees) in Peabody as opposed to 80% only a few years before (Monograph on Peabody, 1983).

Today, leather establishments are still the largest source of manufacturing jobs in Peabody, with 36 firms employing 26% of manufacturing workers. Chemical and allied products follow, with 11 firms employing 19% of manufacturing employees (see Table D.1)(Monograph on Peabody, 1983). Figures D.1 and D.2 show the location of tanneries in Peabody in 1930 and in 1978.

A number of tanneries were formerly located on Foster Street in the northeast corner of CT 2106. Also located on Foster Street was the Danvers Bleachery which closed in the 1950s. The bleachery was engaged in the bleaching, dyeing, and finishing of cotton goods. Today, the only major industry in CT 2106 is Eastman Gelatine Corporation, located on Washington Street and Allen Lane. Prior to Eastman Gelatine, the site was occupied by two glue factories, the Upton Glue factory from 1808 to 1894, and the American Glue factory from 1894 to 1930.

Table D.1. Peabody, Massachusetts Industries in 1930 and 1983

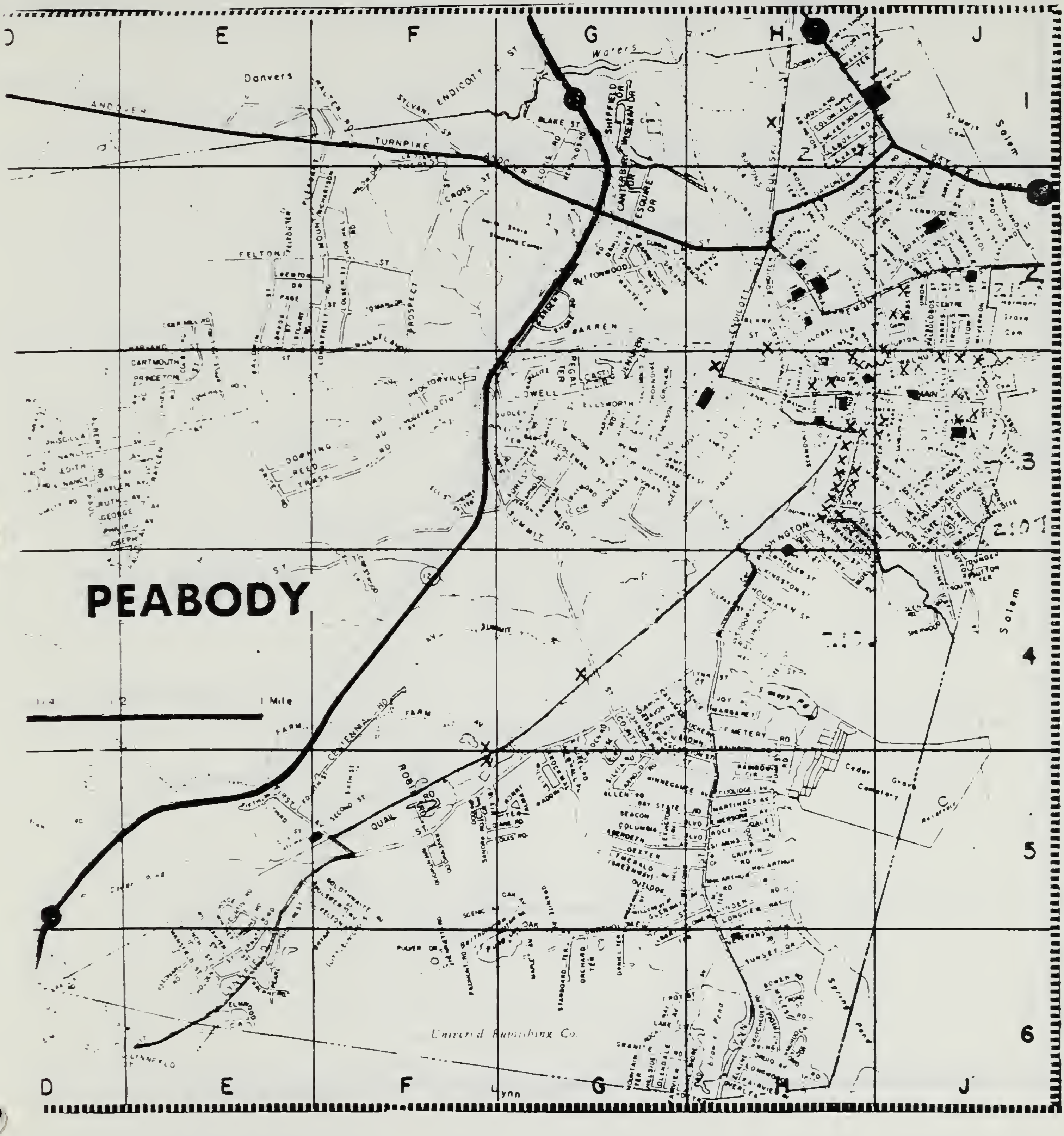
Type of Industry	Number of Units
1930	
Leather	48
Chemical and Allied Products	4
Glue and Gelatine	2
Miscellaneous	6

Source: Maurice Hallinan, retired Sewer Inspector, Peabody Department of Public Services

Type of Industry	Number of Units
1983	
Leather and Leather Products	36
Machinery, except electrical	14
Chemicals and Allied Products	11
Fabricated Metal	10
Printing and Publishing	7
Plastic and Rubber Products	5
Miscellaneous	21

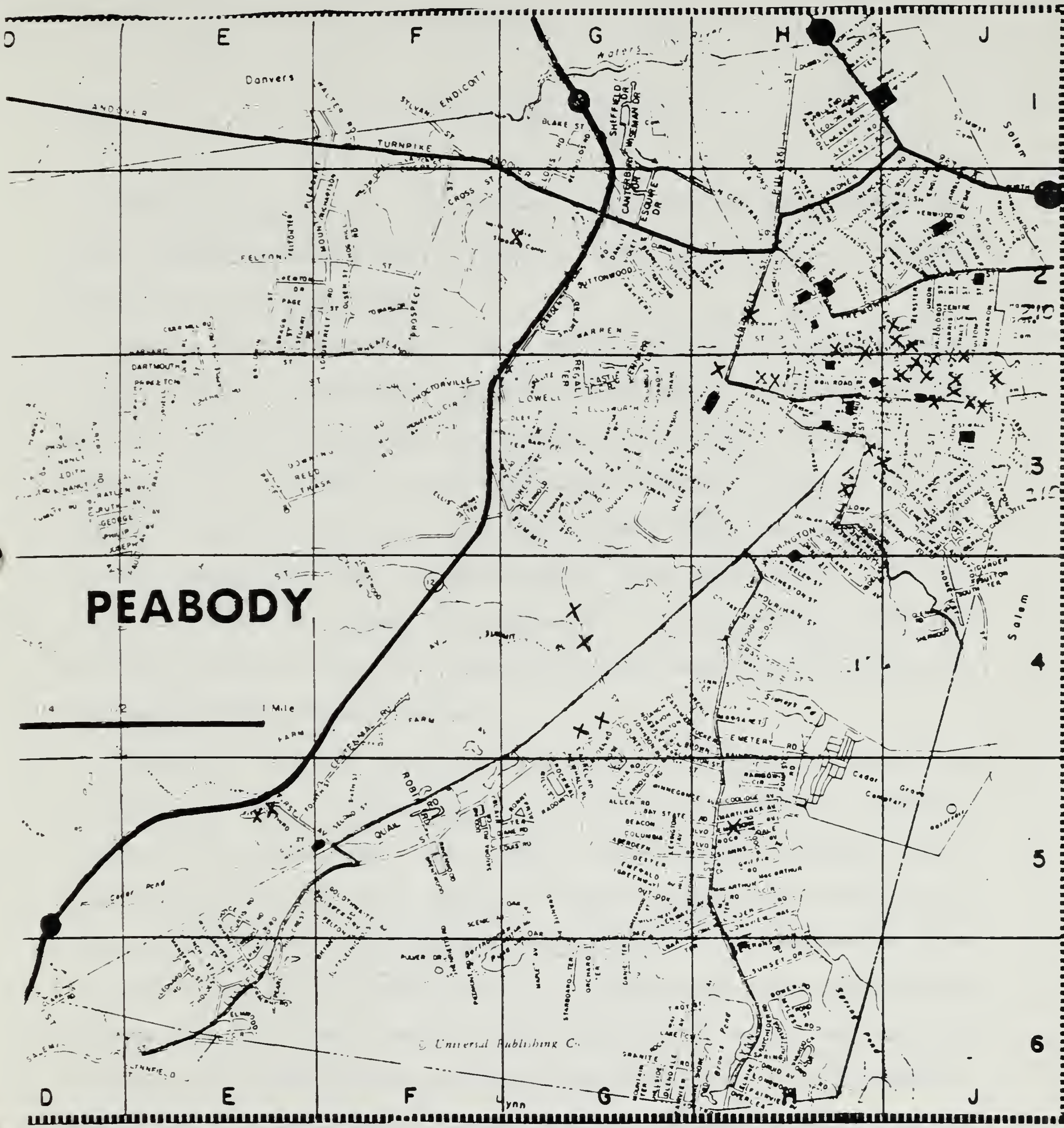
Source: Monograph on Peabody, Massachusetts Department of Commerce and Development, 1983

Figure D.1. Location of Tanneries in Peabody, Massachusetts in the year 1930.



X = Location of Tannery

Figure D.2. Location of Tanneries in Peabody, Massachusetts in the year 1978.



X = Location of Tannery

Appendix E

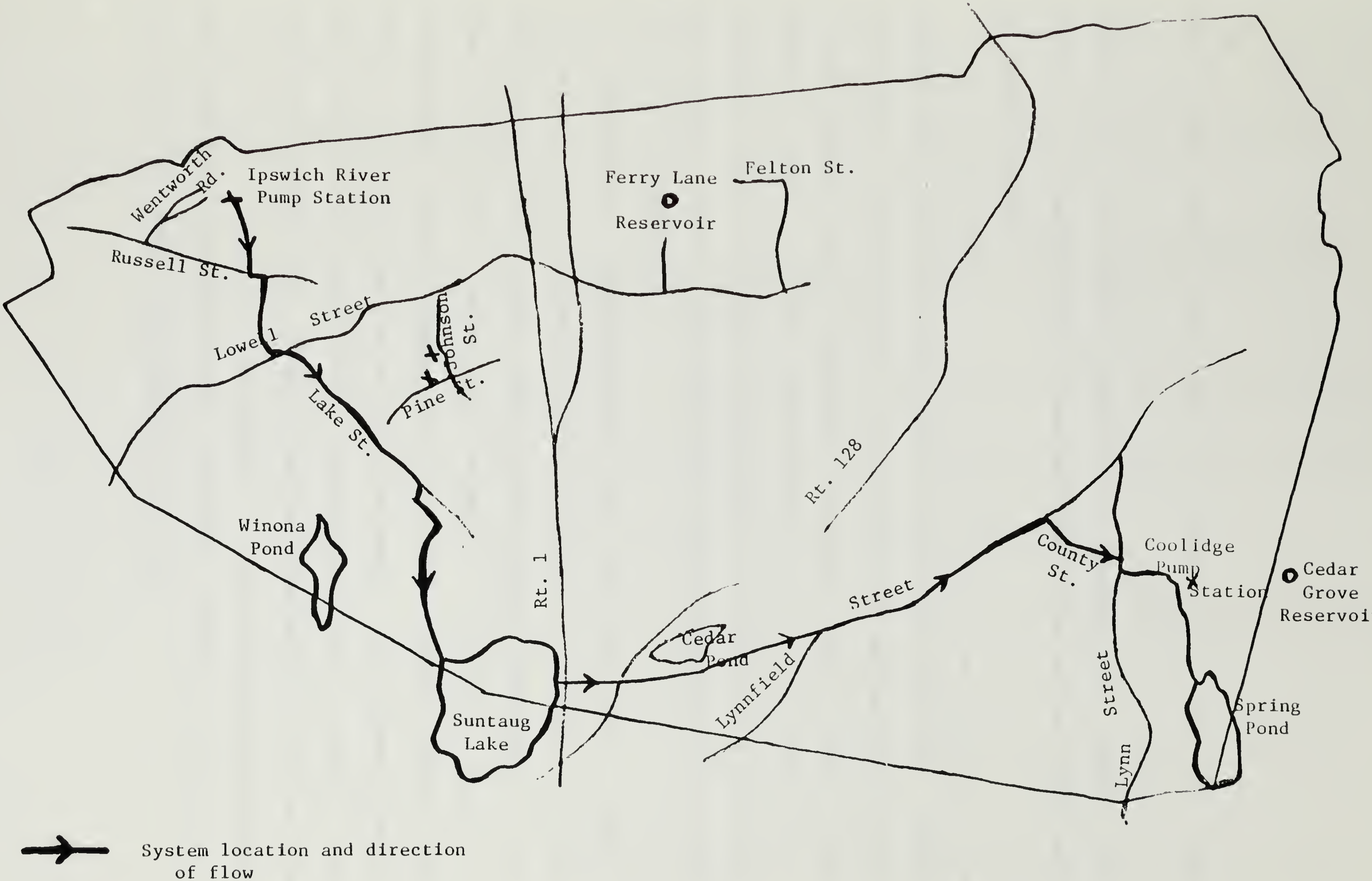
Peabody Water Supply System

The following information was supplied by Jack Brennan and Peter Smyrnios of the Peabody Water Department. Figure E.1 shows the location of various parts of the water supply system.

The system has historically been divided into two systems: the West Peabody system, which serves the western section of Peabody, and the Downtown system, which serves the downtown area and South Peabody. West Peabody water is treated at the Winona Pond treatment plant, which was constructed about 10 years ago. Prior to that, West Peabody received its water from the Johnson Street and Pine Street wells. After the treatment plant was built, the wells were closed for a few years. In the mid to late 1970s, the wells were reopened, and their waters are being pumped to Winona Pond to supplement the West Peabody system.

Except for the addition of the Ferry Lane Reservoir (1960) and the Ipswich River Pump Station (1971), the Downtown system has remained essentially the same since 1905. Water for the system is pumped from the Ipswich River (prior to 1971, the city of Lynn's pumping station was used) to Suntaug Lake. It is also chlorinated at the Ipswich River Pump Station. From the river to the lake, the water travels in pressurized water mains. From Suntaug Lake, the water travels in mains by gravity to Spring Pond. Adjacent to Spring Pond is the Coolidge Pump Station where the water is chlorinated a second time. From the Coolidge Pump Station, the water is pumped into the downtown distribution system. This distribution system contains two elevated

Figure E.1. Peabody, Massachusetts Downtown Water Supply System.



holding tanks, the Ferry Lane Reservoir and the Cedar Grove Reservoir. Water that is not used in the initial distribution is sent to the reservoirs for storage and to help maintain pressure in the system. Since Peabody's water travels in a pressurized system, water will leak out and not into pipes where small leaks may occur.

In the late 1950s, a line from the MDC system was hooked up to the Peabody system. While MDC water has not always been mixed with Peabody water, up to a million gallons a day of MDC water has been mixed into the downtown system at various times during this period. Today, a part of South Peabody is using only MDC water.The switch was made in November or December of 1983, and included the area south of the junction of County and Lynn Streets. Peabody Water Department officials consider this use of MDC water to be more efficient.

Spring Pond is a protected water source. This means that all potential land use activities which could threaten the quality of the water have been identified and action has been taken to protect against those threats. In the case of Spring Pond, no residential or industrial drainage enters the pond. A drainage line that runs adjacent to the pond (since 1932-1933) serves to send surface runoff downstream from the city water supply. Both Eastman Gelatine's waste lagoons and Salem Acres are located downstream from and at a lower elevation than Spring Pond, thereby ruling out contamination of the pond from these sources. The Cedar Grove Reservoir is also upstream from the lagoons and Salem Acres. Suntaug Lake is not a protected watershed on the Lynnfield side of the lake because some homes border the lake.

There has been some controversy over the fact that an old line exists between Cedar Pond and Spring Pond. Apparently, in 1905, a pipe connecting Cedar Pond with the gravity main running between Suntaug and Spring Pond was put in place. While the main was being completed, Cedar Pond water was used for the water supply. However, according to an article from the Peabody newspaper, dated December 20, 1905, after the main was completed, the town would use Suntaug Lake water exclusively. Cedar Pond water could be used in an emergency, as apparently happened in 1916, when Peabody had low rainfall activity and a high demand for water. In another article, dated February 5, 1920, reference was made twice to the fact that the town's supply was Spring Pond, Suntaug Lake, and the Ipswich River. City water officials have also stated that the pipe from Cedar Pond to the main water pipe was closed off, probably in the 1920s. Thus, it appears that water from Cedar Pond has not been used since at least the 1920s.

Appendix F

Peabody Drinking Water

This section contains results of testing that has been conducted on Peabody drinking water. Included is a sample form (Table F.1) that shows parameters routinely tested. Trihalomethane results are also included (Table F.2). In addition, some tests for volatile organic compounds have been done by DEQE (Table F.3). Annual tests are also performed for certain inorganics (Table F.4), and about every three years for certain pesticides (endrin, lindane, methoxychlor, toxaphene, 2,4-D, and 2,4,5-TP). A DEQE official indicated the only test results on pesticides for Peabody showed that none were detected (personal communication,Keating).

Table F.1. Example of Water Supply Analysis (mg/l)

Source A Spring Pond near Gatehouse -229-01S
Source B Suntaug Lake near Gatehouse-229-02S
Source C Ipswich River, Raw water at Intake - 229-03S
Source D Winona Pond Res., Raw - 229-04S
Source E Winona Pond Res., Finished - 229-04
Source F

	A	B	C	D	E	EPA Drinking Water Standards
Sample No.	563865	866	867	868	869	
Date of Collection	3/29/83					
Date of Receipt	3/29/83					
Turbidity	1.1	0.7	0.7	1.4	0.2	1 TU (up to 5 TU)
Sediment	0	0	0	0	0	
Color	23	30	70	45	0	15 color units
ph	7.2	7.2	6.7	7.2	8.0	6.5-8.5
Alkalinity-Total(CaCO3)	18	20	15	21	22	-
Hardness (CaCO3)	33	37	26	35	36	250(guideline)
Calcium (Ca)	7.8	9.5	7.5	7.1	7.8	-
Magnesium (Mg)	3.2	3.1	1.6	4.1	4.0	-
Sodium (Na)	17.	21.	15.	15.	23.	20.(state)
Potassium (K)	1.5	1.6	1.3	1.4	1.5	-
Iron (Fe)	.04	.11	.17	.30	.02	0.3
Manganese (Mn)	.04	.04	.01	.06	.03	0.05
Sulfate (SO4)	16	17	17	14	24	250
Chloride (Cl)	30	37	25	27	30	250
Spec. Cond. (micromhos/cm)	172	198	146	162	200	-
Nitrogen(Ammonia)	.01	.01	.01	.01	.01	-
Nitrogen(Nitrate)	0.4	0.3	0.2	0.4	0.4	10
Nitrogen(Nitrite)	.003	.003	.004	.004	.000	-
Copper (Cu)	.03	.01	.00	.03	.00	1

Table F.2. City of Peabody, Massachusetts Water Testing Results - Trihalomethane Concentrations (ppb)*

Location	4/76	6/80	11/82	2/83	5/83	8/83	11/83	2/84
Winona Plant (finished)	33.9							
W. Peabody Fire Station	55.8		98	73	59	100	64	20
Brown School			33	27	32	79	13	7.5
Central Fire Station			35	21	46	83	27	17
25 Lenox Road			44	33	58	88	90	16
Proctor House Restaurant			112	56	65	97	55	21
Burk School			86	60	66	112	67	25
McCarthy School			91	49	41	109	59	20
Lowe Market			104	18	59	98	63	20
Johnson St. well		0.7						
Pine St. well		0.4						
Water Dept. Tap			75	48	53	96		

* By definition, the THM meets the standard if the average of four quarterly samples is < than 100 ppb. The levels of THMs vary during the course of the year, tending to be highest in August or September.

Table F.3. City of Peabody, Massachusetts Water Testing - State Purgeable Organics Testing Results (ppb)(July 1980)

	Johnson St. Well	Pine St. Well	EPA Health Advisory
Methylene chloride	nd	nd	150 (long-term)
1,1 - Dichloroethylene	nd	nd	70 (long-term)
1,2 - Transdichloroethylene	nd	nd	270 (10-day)
1,2 - Dichloroethane	nd	nd	none
1,1,1 - Trichloroethane	2.7	3.2	140 (long-term)
Carbon Tetrachloride	nd	nd	20 (10-day)
Trichloroethylene	12.7	0.4	80 (long-term)
Tetrachloroethylene	nd	nd	20 (long-term)

* nd = not detected

Table F.4. Inorganic Chemical Concentrations (ppm)
(Peabody, Massachusetts Water Dept. Tap - Downtown System)

	1979	1981	1982	MCL*
Arsenic	0.0003	0.000	0.000	0.05
Barium	0.00	<0.10	0.000	1.0
Cadmium	0.00	0.00	0.000	0.01
Chromium	0.00	0.00	0.000	0.05
Lead	0.00	0.00	0.001	0.05
Mercury	0.001	0.0005	0.0000	0.002
Selenium	0.0004	0.000	0.000	0.01
Silver	0.00	0.00	0.000	0.05
Fluoride	0.2	<0.2	0.3	1.4 - 2.4
Nitrate (as N)	0.6	0.1	0.2	10
Sodium	-	26	19	20**

* EPA sets a maximum contaminant level (MCL) for certain contaminants in drinking water. In setting the MCL, which should protect against adverse health effects, EPA assumes that a male adult drinks 2 liters of water/day over a lifetime.

** Massachusetts DEQE standard for sodium is 20 ppm.

Table F.5. City of Peabody, Massachusetts Water Testing Results*

(February 29, 1984)

	UNITS	Winona Pond	Suntaug Lake	Upper Spring Pond	Lower Spring Pond
Total Organic Carbon	ppm	22.	11	45	4
Total Organic Halogens	ppm	0.13	0.085	0.046	<0.020
Arsenic	ppb	<1	X	X	<1
Cadmium	ppm	<0.002	X	X	<0.002
Chromium	ppm	<0.01	X	X	<0.01
Copper	ppm	<0.01	X	X	0.02
Lead	ppm	<0.08	X	X	<0.08
Mercury	ppb	<1	X	X	<1
Selenium	ppb	<1	X	X	<1
Silver	ppm	<0.005	X	X	<0.005
Zinc	ppm	0.01	X	X	0.01
Antimony	ppm	<0.07	X	X	<0.07
Beryllium	ppm	<0.01	X	X	<0.01
Nickel	ppm	<0.02	X	X	<0.02
Sodium	ppm	14	X	X	22

* According to John Seites, Director, Peabody Department of Public Services, the data is subject to analysis and verification.

Appendix G

Dumpsites in Peabody

Figure G.1 indicates present and former dumpsites in Peabody. Table G.1 lists the types of wastes deposited in the dumpsites. With the exception of the Eastman Gelatine lagoon area, none of the dumpsites are located in CT 2106.

Many sites contain waste from the tannery industry, which include chromium, copper, lead, zinc, grease from leather scraps, and hide wastes. Methane can accumulate as hides decompose, and hydrogen sulfide can be emitted, causing a strong foul odor, especially in hot or damp weather. Today, most tannery wastes are discharged into the sewer system.

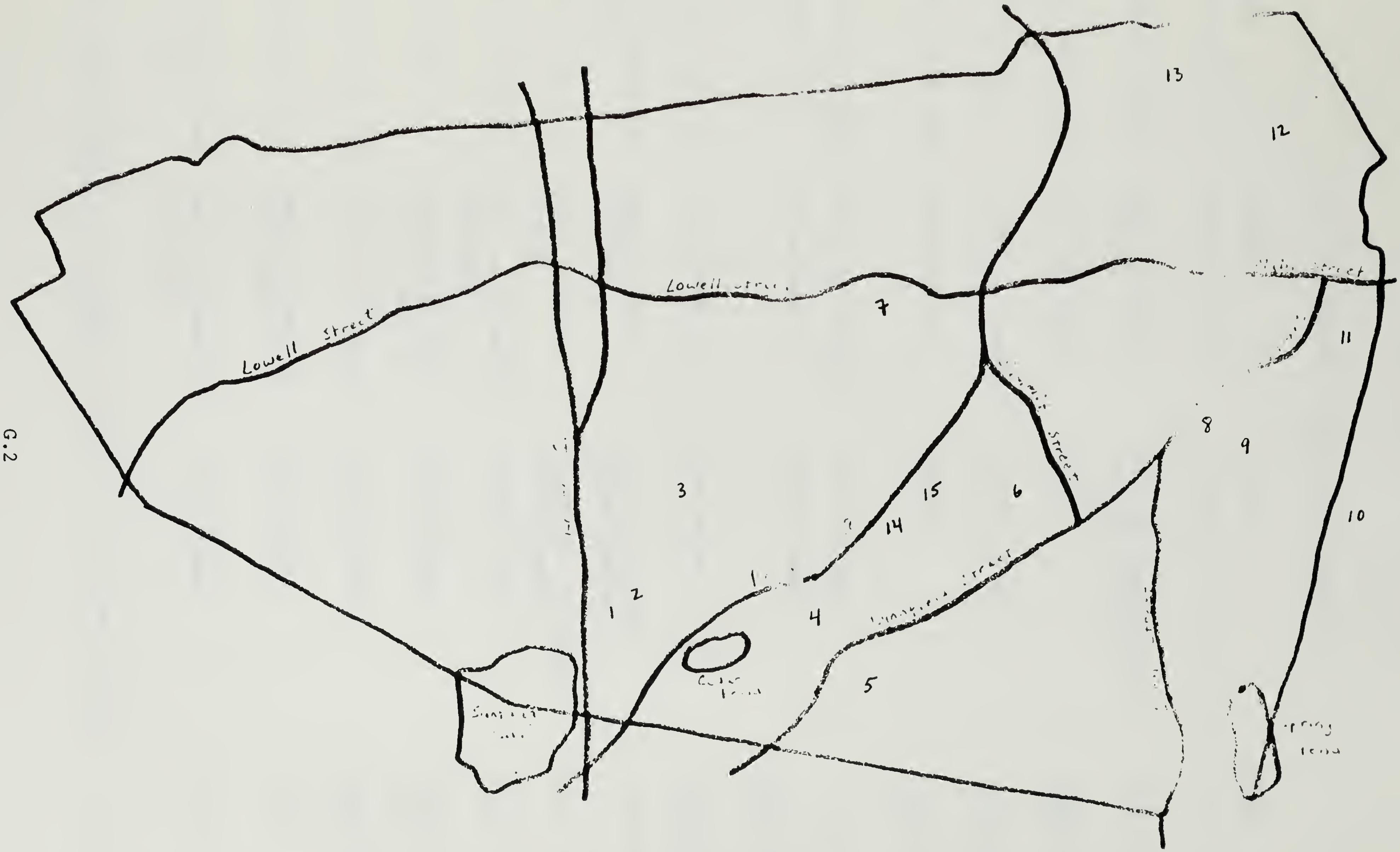


Figure G.1. Peabody, Massachusetts Dumpsite Locations (see Table G.1 on the following page for names and contents of dumpsites corresponding to the numbers shown on this map).

Table G.1 Peabody, Massachusetts Dumpsites

	Name	Source*	Waste	Status
1.	GCR Landfill	Board of Health	wreckage from demolished buildings	active dump
2.	Peabody Landfill	Dept. of Public Services	various industrial and residential wastes	active dump
3.	Papanickolas Dump	Board of Health	tires	closed at least three years ago
4.	Old City Dump	Historical Society	tanning wastes	closed; covered with gravel
5.	Cedar Swamp Dump	Louise Hamilton	unknown	closed around 1920; covered with soil
6.	Hunt-Rankin/Remis	Historical Society	tanning wastes	closed in 1950s
7.	Center Field	Louise Hamilton	tanning wastes	closed 20-30 years ago; currently housing site
8.	Wheeler St.Dump	Louise Hamilton	glue wastes	closed around 1920 currently residential
9.	Eastman Gelatine Lagoons	Dept. of Public Services	lime sludge; glue factory wastes	closed 1983
10.	Salem Acres	Dept. of Public Service	sewage grit and scum; tanning wastes	closed 1969
11.	Pierpont Street	Dept. of Community Development	tanning wastes	under development
12.	Mannix Dump	Maurice Hallinan Louise Hamilton	tanning wastes	closed; currently residential
13.	A.C. Lawrence Dump	Historical Society	tanning wastes	closed about 1978; filled over
14.	Centennial Industrial Park	Dept. of Community Development	lime sludge	closed
15.	Centennial Industrial Park	Dept. of Community Development	pig carcasses	closed

*Some of this information is on the recollection of long-time residents. In some cases, exact locations cannot be specified.

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Appendix H

Eastman Gelatine

Eastman Gelatine manufactures high-quality photographic gelatines. One stage in the process consists of soaking animal bones in a lime slurry to extract gelatine. Chemicals used in the process include dicalcium phosphate, and lime or calcium carbonate. One waste from the gelatine extraction process is a sludge made up of calcium hydroxide, calcium carbonate solids, and animal bone and tissue. A waste called "tankage" is the only other waste generated from the gelatine process. Tankage contains 90% water, as well as solid bone pieces (Eastman Gelatine Lime Lagoon Site History). Tankage has been dumped in the lagoons across Washington Street from the plant for over 50 years (see Fig. H.1). As of March 1983, the company ceased dumping in the lagoons and began trucking the sludge to the South Essex Sewerage District (SESD) treatment facility in Salem (C.T. Main, pp. 2-1).

As a result of citizen complaints and the concern of DEQE, Eastman Gelatine hired consultants to study the lagoon area. A consulting firm, C.T. Main, reported on the topographical, geological, and hydrological conditions before assessing impacts of the lagoons on the surrounding area. The major movement of water into and out of the lagoons, according to C.T. Main, is simply precipitation and evaporation (C.T. Main, pp. 1-1). There is, however, some drainage from the lagoons to Strongwater Brook. A potential aquifer was found to the east of the lagoons (around the Meadow Pond area). The Main

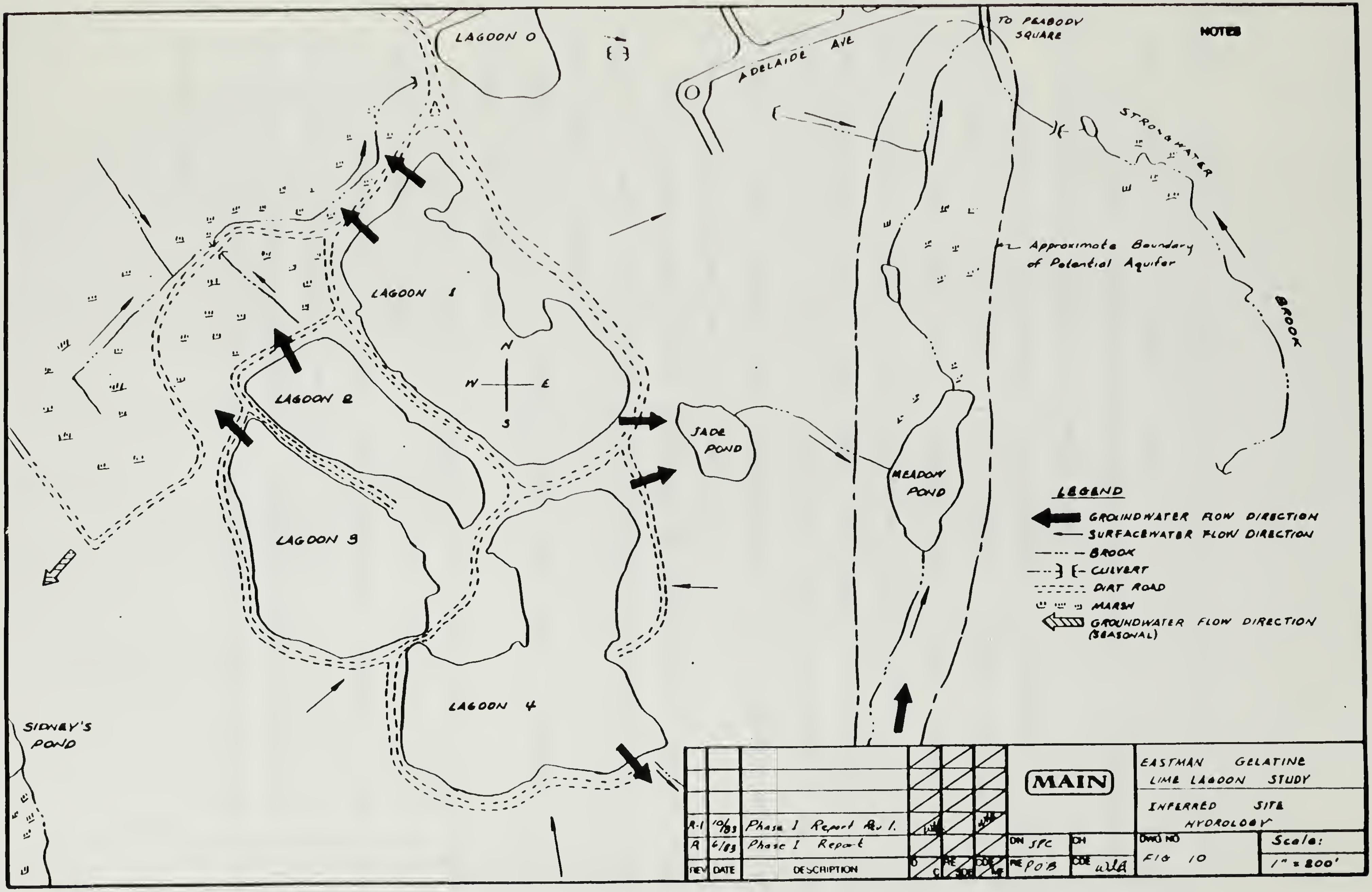

Figure H.1. Eastman Gelatine's Waste Lagoons, taken from C.T. Main's report.

report concluded that seepage and runoff from the lagoons enter the aquifer (Main, pp. 4-7 and 4-8). Likewise, seepage enters Sidney's Pond to the west of the lagoons. While these situations should be addressed, neither the aquifer nor Sidney's Pond are sources of drinking water.

Some tests have been conducted on the contents of the lagoons. In August 1983, DEQE staff tested for volatile organic compounds and metals in groundwater below lagoon one (in service from the 1930s to about 1963). Ethanol, dimethyl sulfide, tetrahydrofuran, and methyl butanone were found in concentrations which were not quantified. Also found were methyl ethyl ketone (380 ppb) and toluene (1800 ppb). No elevation in metal concentrations existed in one well. The other well (well 104) had greater than acceptable levels of chromium, lead, cadmium, and silver (see Table H.1.).

DEQE conducted additional testing in the lagoon area in November 1983. Samples were taken at lagoon zero (which has been out of service since the 1930s) and at a monitoring well located in a dike around lagoon one. Groundwater under lagoon one had unacceptably high levels of chromium, lead, cadmium, silver, and mercury.

Volatile organic compounds were measured from water below the dike around lagoon one. This spot was picked to determine the extent of migration of organic compounds that had been found in the August testing in a monitoring well located in the middle of the lagoon. Only dimethyl sulfide, dimethyl disulfide, and toluene were detected. The first two were not quantified while the toluene concentration was 54 ppb. The results of lagoon water testing are shown in Table H.1.

Table H.1. Eastman Gelatine Lagoon Water Testing by DEQE

Volatile Organics (ppb)	August 1983 Lagoon 1 Well 104	August 1983 Lagoon 1 Well 106	November 1983 Lagoon 1 Well 102	November 1983 Lagoon 0 Well 111	EPA HA*
Ethanol	*		nd		-
Dimethyl sulfide	*		*		-
Tetrahydrofuran	*		nd		-
MEK	380		nd		750 (10-day)
Methyl butanone	*		nd		-
Toluene	1800		54		340 (long-term)
Dimethyl sulfide	nd		*		

nd = not detected
* = detected but not quantified

Metals	August 1983 Lagoon 1 Well 104	August 1983 Lagoon 1 Well 106	November 1983 Lagoon 1 Well 102	November 1983 Lagoon 0 Well 111	Mass. Groundwater Standards
Chromium	0.12	0.00	0.01	0.09	0.05
Lead	1.1	0.03	0.07	0.73	0.05
Arsenic	0.004	0.003	0.004	0.01	0.05
Cadmium	0.10	0.00	0.00	0.09	0.01
Nickel	1.2	0.00	0.21	0.45	-
Silver	0.12	0.00	0.01	0.06	0.05
Calcium	11000.	5.7	550.	5300.	-
Mercury			0.0008	0.048	0.002

* EPA established Health Advisories (HA) for contaminants in drinking water. These advisories are not legally enforceable.

** The Commonwealth of Massachusetts has promulgated groundwater quality standards (314 CMR 6.00). The standards used here for comparison are standards for Class I and II groundwater. Class I groundwater is designated as a source of potable water supply. Class II groundwater is designated as a source of potable mineral waters, for conversion to fresh potable waters, or as raw material for the manufacture of sodium chloride or its derivatives or similar products. Class III groundwater standards are less stringent, as they were developed for groundwater not used as a source of potable water supply.

In November 1983, DEQE took core sediment samples from lagoon zero. The levels of arsenic and mercury were elevated. Lead was within the range expected for uncontaminated soils, but well above the mean expected values. The sampling results follow:

	Core samples	Uncontaminated soils*	
	levels (ppm)	mean(ppm)	range (ppm)
Arsenic	64.0	6	0.1-40
Mercury	5.8	0.03	0.01-0.2
Lead	155.0	10	2-200

* EPA Publication "Hazardous Waste Land Treatment", SW-974, September 1980.

Local residents have complained for years about odor originating from the Eastman Gelatine plant and lagoons. One source of odor in the surrounding neighborhood could have been a chemical called monomethylamine, which was used by the company to remove hair from animal skins until 1978, when its use was stopped (Pagnotto). It is not known, however, how much monomethylamine may have been in the ambient air.

In response to complaints about odor from the lagoons, Eastman Gelatine hired consultants, TRC, to take air samples in the lagoon area. A mobile gas chromatograph-mass spectrometer instrument was used. Samples were taken directly over the lagoons. They were also taken downwind and upwind from the site. The upwind sites were near the Cedar Grove Cemetary and south and north of Sidney's Pond. The downwind sites were east of Meadow Pond, and just southeast of Welsh School.

The only substances detected were four kinds of amines and ammonia. These were detected over the lagoons but not at any of the upwind or downwind sites. The levels were as follows:

C-1 amines	1-9 ppt
C-2 amines	2-3 ppt
C-3 amines	60-900 ppt
C-4 amines	0-1 ppb
ammonia	25 ppb

The samples were taken in April 1983. The day was cloudy and cool. Thus, volatilization of the compounds would be less under these conditions than under warmer conditions.

An Eastman Kodak official stated that, at the levels found in this sampling round, none of the amines alone would have caused an odor (Mathews). However, together they may act synergistically to produce an odor.

Amines can be converted to nitrosamines under neutral or acidic conditions, and in the presence of nitrogen oxide compounds (see Section 4.1.b). According to an Eastman Kodak spokesman, if nitrosamines had been present in the lagoon area in concentrations greater than 1-5 ppb, they would have been detected.

Eastman Kodak also conducted 344 "odor patrols" between May and October 1983. Trained individuals visited 20 sites to determine if an odor was present. The sites bordered an area from Rainbow Road to the west to Sherwood Avenue to the southeast. They found that May, Hourihan, and Granite Streets were impacted the most with regard to odors. Their conclusion was that 2% of the time, the average person would have detected some odor, and 3.7% of the time, a more sensitive person would have detected the odor. The odor was probably originating from the amines. Discussion is currently underway on whether to continue with the odor patrols for the coming year.

Appendix I

Salem Acres

A consulting firm, the NUS Corporation, conducted tests at Salem Acres, which has been nominated as a Superfund site. Results of the testing are contained in a site inspection report which has not yet been released. John Panaro of NUS, however, supplied some preliminary results.

The site contains sludge waste (grease and grit), possibly some tannery waste, and sewage. NUS sampled soil from the sludge pits, as well as surface water and groundwater. Two surface water samples were from Strongwater Brook, one next to the pits, and one further downstream (near the Peabody/Salem border). Three groundwater samples were taken from the swamp area. One groundwater sample was taken at an Eastman Gelatine well, and another at a private well across Highland Avenue along Swampscott Road in Salem. The latter well was the closest well downstream from the pits. All water samples had "expected levels" of metals (Panaro). The results of tests for organic compounds in all water samples have not yet been received. Soil samples from the pits indicate that chromium levels are elevated in two pits (800 - 900 ppm), and are below 25 ppm in the other two pits. The quality of the data is still being evaluated.

Appendix J

Pierpont Street Park

A number of soil samples have been taken at Pierpont Street Park which was once the site of two leather companies, B.M. Moore and Central Leather. The park is now a playground. Strongwater Brook flows through the site, which is believed to have been used for dumping tannery wastes (Peabody Community Development Department, local citizens).

In August 1983, soils of the park were analyzed for heavy metals by Skinner & Sherman. The results are shown in Table J.1. The mean and range of values for uncontaminated soils are derived from the EPA Publication "Hazardous Waste Land Treatment", SW-974, September 1980.

The testing was insensitive as to whether the chromium was in the more toxic hexavalent form, or the less toxic trivalent form. Inferences on the valence state of the chromium cannot be made, since the half-life of hexavalent chromium in soil is not known. According to an EPA official, however, the conversion of hexavalent chromium to trivalent chromium is probably dependent on the organic content of the soil. The higher the organic content, the faster the breakdown of hexavalent chromium.

Table J.1. Soil Testing Results at Pierpont Park, Peabody, Massachusetts

(Skinner & Sherman, 1983)

Metal	Levels(ppm)	Mean Value and Range (ppm) of Uncontaminated Soils	
		Mean	Range
Aluminum	80,000-800,000*	-	
Arsenic	8.7	6	(.1-40)
Chromium	1368	100	(5-3000)
Copper	80	20	(2-100)
Iron	2400-24,000*	-	
Lead	2400-24,000*	10	(2-200)
Magnesium	80,000-800,000*	-	
Manganese	800-80,000*	850	(100-4000)
Nickel	8-80*	40	(5-5000)
Silicon	80,000-800,000*	-	
Sodium	8000-80,000*	-	
Titanium	2400-24,000	-	
Vanadium	8-80	100	(20-500)
Zinc	80	50	(10-300)

* The exact concentration lies somewhere in the range shown

While the chromium level found by Skinner and Sherman is not beyond the expected range, it is still elevated. DEQE officials qualified the sampling results as follows:

> "It is difficult to characterize the pollution potential of a site based upon an analysis of a single grab sample of soil. Site location and history, pollutant types and quantities, hydrogeological setting, pathways of exposure, and the types and locations of sensitive receptors must necessarily be considered. Additionally, since sampling procedures were not observed, the quality of submitted data cannot be verified." (In a letter from Richard Chalpin to Peter Angeramo).

Thus, DEQE officials believe that more study is needed to characterize the extent of contamination of the site.

Goldberg & Zoino tested soils adjacent to this site in 1981. The soils were analyzed for heavy metals (arsenic, cadmium, chromium, lead, mercury, thallium) (see Table J.2). The analysis used an elutriate test procedure where soil samples are subjected to processes intended to remove any leachable metals from soil particles. The results of this test can be used to predict the potential for groundwater contamination. The "leachate" produced is then analyzed for the metals. The results are compared to EPA drinking water standards, as well as to levels which would classify the soil as a hazardous waste under the Resource Conservation and Recovery Act (RCRA). For chromium and lead, two samples showed levels greater than drinking water standards. No levels, however, were great enough to classify the soil as a hazardous waste.

Table J.2. Soil Testing Results at Pierport Park, Peabody, Massachusetts
(by Goldberg & Zoino, 1981)

	Samples **						
	1	2	3	4	5	6	7
Arsenic	<.002*	<.002	<.002	.110	<.002	<.002	<.002
Cadmium	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Chromium	.09	<.01	.33	.03	<.01	.04	<.01
Lead	<.05	.07	<.05	.07	<.05	<.05	<.05
Mercury	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Thallium	<.1	<.1	<.1	<.1	<.1	<.1	<.1

* All concentrations are in parts per million (ppm)

** Samples 1-4 were collected beneath a concrete floor slab of an old tannery building. Samples 5-7 were collected beneath the pavement of the adjacent parking and road areas.

	EPA Drinking Water Standard (ppm)	RCRA Level (ppm)
Arsenic	.05	5.0
Cadmium	.01	1.0
Chromium	.05	5.0
Lead	.05	5.0
Mercury	.02	0.2
Thallium	-	-

Appendix K

Strongwater Brook

In 1974, Green Engineering Affiliates, Inc. conducted a study called "Industrial Discharge Survey of North River and Tributaries". One of the tributaries to the North River is Strongwater Brook. Two samples of the brook's water were collected. One was immediately downstream of the bridge between Swampscott Street and the William Welsh School. The other sample was taken near the junction of the brook with the North River. Results of the sampling are shown in Table K.1. These pertain to both locations.

Table K.1. Strongwater Brook Sampling Results, Peabody, Massachusetts.

(Green Engineering Affiliates, Inc., 1974)

	Levels (ppm)	Massachusetts Groundwater Standards (ppm)
Cadmium	<0.05	0.01
Cobalt	<0.1	-
Copper	<0.05	1.0
Lead	<0.1	0.05
Chromium	<0.05	0.05
Nickel	<0.1	-

Appendix L

Peabody & GCR Landfills

Testing was conducted by a consultant to DEQE, Tighe and Bond/SCI, of groundwater, surface water, and leachate at the Peabody Landfill. The landfill has been used by the city since the 1950s and is located in the Goldthwaite Brook Drainage Basin. Waters within this basin are used by Eastman Gelatine for industrial purposes.

Tests done in 1980 and 1981 showed that groundwater underneath the landfill had become highly contaminated, particularly with chlorides, iron, chromium, and total dissolved solids (EIR, Tighe and Bond, pp. 4-10 and 4-11). The report noted, "Two significant factors which impact the water quality of the basin are leachates from the local landfill operations and runoff from the regional highway system" (EIR, Tighe and Bond, pp. 4-10). Tighe and Bond also tested for certain organic compounds (PCBs and pesticides) in both surface and groundwaters, and none were detected.

Five tests were conducted in March-August 1983 and January 1984. Three sampling sites were on the site itself, one in a well east of the landfill, and one at pumphouse #3, a well owned by Eastman Gelatine. According to a spokesman from Tighe and Bond, no unusual levels were found. In the volatile organic group, most were not detected. Of those detected, all were within state or federal guidelines.

Surface and subsurface waters in the basin where the landfill is located eventually discharge into Goldthwaite Brook (EIR, Tighe and Bond, p. 4-9).

Adjacent to the Peabody landfill is the GCR landfill, where groundwater testing was done in September 1983 by GHR Engineering. The standard water tests as well as tests for volatile organic compounds were conducted in four monitoring wells around the site.

Leachate from the landfill is contaminating groundwater (GHR, pp. A-13). Of the metals detected (iron, manganese, zinc, calcium, magnesium), concentrations were well below the Massachusetts Groundwater Standards for Class I and II groundwater. Five different volatile organic compounds were detected in two wells, and none were detected in the other two wells. None of the compounds, however, exceeded EPA's health advisory levels (where such levels exist) for these contaminants in drinking water. The groundwater of this region drains eventually to the south and southeast and does not impact on Peabody's water supply.